ANNALS OF SURGERY

VOL. XXXVIII AUGUST, 1903 No. 2

ORIGINAL MEMOIRS.

THYROIDECTOMY AND SYMPATHECTOMY FOR EXOPHTHALMIC GOITRE.[1]

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THE surgical treatment of exophthalmic goitre has excited much interest of late years because of the failure of medical treatment in many cases; although, if the disease has not progressed too far, and if the circumstances of the patients render it possible to carry out systematic treatment for a sufficiently long time, rest, hygienic measures, and proper medication will generally produce a cure, or at least hold the symptoms in check. Surgical treatment is able, however, to cure many cases which have not yielded to medicine. But it has very serious dangers of its own, especially the danger of acute exacerbation of the symptoms known as thyroidism, or thyroid poisoning, which may follow any operation in these patients whether the operation concerns the thyroid gland or other parts of the body.

The various operative measures which have found favor in exophthalmic goitre are,—

1. Thyroidectomy of one-half of the gland. Resections

[1] Read before the American Surgical Association, May, 1903.

of smaller portions and enucleation of cysts or tumors appear to be much more dangerous in these patients, on account of the greater danger of hæmorrhage (Kocher).

2. Ligation of arteries.

3. Erythyreopexy.

4. Sympathectomy, or partial or total excision of the cervical ganglia.

To take the minor operations first, erythyreopexy, which has been tried in exophthalmic as well as simple goitre, has not given permanent results, although some of the cases were temporarily improved. The operation has never been a popular one, and the surgeons who once advocated it appear to have lost interest in it. In this operation the gland is exposed by making free incisions through the parts covering it, and when exposed it is partly raised from its bed and left lying in the open wound covered only by the dressings. It tends to shrink and atrophy.

With ligation of arteries the writer has no personal experience, as he has done it only in connection with other operations. Kocher has found that ligation alone is seldom sufficient, but recommends it as a preparatory treatment for cases in which the patient's condition is too serious for a thyroidectomy, ligating both superior thyroids for instance, and later, when some improvement has been obtained, proceeding to the graver operation. It is to be noted that ligature of the inferior thyroid vessels is almost as serious an operation as thyroidectomy. He also employs it at the same time as thyroidectomy of one-half of the gland, tying one or both arteries of the remaining half when the latter is very large; or, finally, the arteries of the other half may be ligated after removal of one-half of the gland if improvement is not obtained or if the gland is growing. In Kocher's ("Ueber Morbus Basedowi," *Mittheilungen aus der Grenzgebiete*, ix (1902), Heft 1 and 2, p. 1) fifty-nine operations done for exophthalmic goitre, he did thyroidectomy of one-half in fourteen cases; ligation of arteries in sixteen cases; both at once in nineteen cases; thyroidectomy of one-half, resection of

other, in four cases; thyroidectomy of one-half, resection and ligature, in three cases; ligature and partial resection in one case; ligature and sympathectomy (partial) in three cases.

5. Thyroidectomy.

The majority of Kocher's operations were thyroidectomies. In all he operated upon fifty-nine patients, with a death-rate of 6.7 per cent. (four cases). Seventy-six per cent. were cured, 14 per cent. improved, 3.3 per cent. slightly improved. He acknowledges no failures.

Rehn ("Die chirurgische Behandlung des Morbus Basedowi," *Mitth. a. d. Grenzgeb.*, vii (1900), Heft 1, p. 165) collected 177 thyroidectomies by thirty-seven operators (Kocher not included) and 114 cases from literature. The mortality of the first series was 13.5 per cent., of the second, 11.4 per cent. The mortality of ninety-five severe cases of the picked operators series was 22 per cent. (twenty-one cases). The cures of these two series was claimed to be 57.6 and 54.8 per cent. respectively, figures practically identical, and 26.5 and 27.9 per cent. respectively were improved.

The writer's experience with thyroidectomy has consisted of eleven cases, with three deaths (all due to acute thyroidism without wound complications), six cures, one improved and one lost sight of. The death-rate is greater, otherwise the results correspond.

As to the details of the symptoms in improvement, the variations of severity in the symptoms before operation, the treatment before and after operation, and other interesting details, I must refer you to the histories subjoined. The operations were all performed in the same way. The gland was usually exposed by a transverse incision, the superior thyroid vessels tied, the gland retracted inward after ligation of superficial veins, and the inferior thyroid vessels secured, the artery usually being tied near its origin, the isthmus then divided, leaving a generous layer of gland tissue over the neighborhood of the recurrent laryngeal nerve. The isthmus was sometimes crushed and ligated *en masse* with catgut, sometimes divided with the cautery. Each was given a trial with the idea that

it might affect the occurrence of thyroid poisoning, but the latter followed both methods. Great gentleness was employed in handling the gland, to avoid the supposed danger of causing vascular or lymphatic absorption of thyroid material. General anæsthesia with ether was employed, because we were afraid of the action of cocaine on the heart, and because it was supposed that the strain of an operation under local anæsthesia might be too great for these nervous patients. I shall return later to a consideration of this subject. In these operations the development of the condition known as acute thyroidism is the principal danger I have observed. The operations were not unusually difficult, the tumors were not unusually vascular (with two exceptions), and the anæsthesia was fairly well borne, although some of the patients became somewhat cyanotic. No accidents followed from this cause.

Sympathectomy.—Suggested by Edwards, and popularized by Jaboulay and Jonnesco, operations upon the sympathetic ganglia of the neck have given excellent results in the treatment of this disease. Jaboulay ("Chirurgie du grand sympathetique et du corps thryroïde," Lyons, 1900), who is the most ardent advocate of the partial operations, removes the superior ganglion only, but his results are not very satisfactory. In seventeen cases he had two deaths from erysipelas and pulmonary congestion, not due to any peculiarity in the operation itself. He followed five cases for a year or more with the result of two cures,—two "cures," but there was a returning enlargement of the thyroid when last seen, and one case with some heart symptoms which he terms "cardiopathy." Balacescu ("Die totale und bilaterale Resection des Sympathicus cervicalis beim Morbus Basedowi," *Archiv für klinische Chirurgie*, lvii (1902), Heft 1, p. 59) has collected twenty-seven cases of partial operations, including Jaboulay's, and figures out 33.3 per cent. cures, 40.7 per cent. improved, 7.4 per cent. not improved, and 18.6 per cent. deaths.

The complete bilateral removal of all three of the sympathetic ganglia of neck has been most often employed by

Jonnesco, who first advocated it as necessary. He has operated thirteen times, and, if we add four cases by French surgeons (collected by Balacescu), we obtain seventeen cases, of which it is said that ten were cured (58.9 per cent.), five improved (29.4 per cent.), two not improved (11.7 per cent.). There were no deaths. (But I think Case XVII with death from chloroform should have been included.)

Alarmed at the frequency of thyroid poisoning after thyroidectomy and attracted by the immediate good results claimed for sympathectomy, the writer began to do the operation two years ago, and has performed it in seven cases. But the results have not been much better than those of thyroidectomy, for there have been two deaths from acute thyroid poisoning and one death probably due to the anæsthetic. All the operations were done with ether anæsthesia, but it was made as light as possible; and in the case in which it was supposed that death was due to the anæsthetic, the only symptoms were a gradually increasing cyanosis and pallor. I think the death was caused by an accumulation of mucus in the air passages taking place so slowly that it was not observed, as there was very little mucus in the pharynx or larynx.

The operations were performed on both sides in one sitting, except in one case. In the first case (XII) the incisions were made posterior to the sternal portion of the sternocleidomastoid; in all the rest it was made along the anterior or internal border of that muscle. The anterior incision has the advantage of allowing access to the superior ganglion without extending quite so high, thus leaving a scar, which is more easily concealed by the clothing. The usual technique of the operation was exposure of the sheath of the great vessels, retraction of the vessels to the inner side, accompanied by displacement of the goitre, exposure of the sympathetic trunk in the middle of the wound, tracing it upward to the superior ganglion. The latter was then isolated bluntly with forcible retraction of the upper angle of the wound, an artery clamp placed upon the nerve just at the upper limit of the ganglion, and the ganglion twisted out. The nerve was then followed

downward, and the second and third ganglia isolated and removed. The second ganglion is sometimes in close relation to the inferior thyroid artery, which may have to be ligated in order to remove it intact, the strands of the nerve sometimes separating and lying both in front and behind the artery. The second ganglion also is often very small or fused with the third. The third cervical ganglion is often fused with the first dorsal ganglion and will have to be separated with scissors or knife after blunt isolation. I look upon this part of the operation as the most difficult because of the considerable depth of the ganglion and the proximity of important structures. The recognition of the nerve also presents serious difficulties in some cases. It is very variable in size and appearance. In one case the nerve was represented by a number of separate fine filaments running parallel to each other with considerable intervals between them, instead of a well-developed trunk. In any case, it should be a cardinal rule not to inflict any damage upon a structure supposed to be the nerve until it has been proved to be the sympathetic by tracing it to the ganglia.

It is rather early to judge of results, but so far the record is three cases apparently cured, one improved, none unimproved, three cases died.

The main object of this paper is to present the danger of acute thyroidism or thyroid poisoning in surgical operations upon persons with exophthalmic goitre, and to discuss its possible causes and means of prevention. The symptoms of this condition are the following. The patient may have been put to bed in good condition after operation, having required no stimulant, and apparently ready for a good convalescence. The temperature will, however, soon rise to 102° or 103° F. Usually it will reach 103° or 104° F. in twenty-four hours, and then continue to 106° or 107° F. With the rising temperature, the pulse will run up to 130, 150, even 200. The face will be flushed (in thyroidectomy as well as in sympathectomy), the breathing hurried and superficial. The patient will be nervous, twitching, tremulous, talking a great deal.

Anxiety, however, I have not usually seen,—the mind generally remaining clear and calm enough to the end. In some cases coma has been present, but this is unusual. Death may be sudden at the last; in one case the patient had apparently been sleeping quietly up to a few minutes before, waking with urgent dyspnœa, and dying of sudden arrest of the heart. In other cases death comes from gradual exhaustion or from œdema of the lungs. Morphine will quiet the restlessness, but we could not find any drug to control the heart. Strychnine, digitalis, digitalin, saline intravenous infusion, and even aconite have been tried in vain. They are useless or even make the heart worse. One case only survived over twenty-four hours of these symptoms. In one case only of the sympathectomies did serious symptoms like these terminate in recovery. The rest had fever under 102° F. and a slower pulse. The remedies used were those mentioned,—morphine, bromides, aconite, and an ice-bag to the heart region.

The temperature after operation in nearly all of these cases was very high, even when they recovered with primary union of the wounds and without any other marked symptoms of the thyroid state. There is no leucocytosis with this rise of temperature. The study of this fever is interesting.

Thus, of the cases which recovered, the highest temperature attained within twenty-four hours after the operation was (thyroidectomy) I, $102\frac{3}{5}$° F.; III, $103\frac{1}{5}$°; IX, 103°; X, $101\frac{2}{5}$°; (sympathectomy) XIV, 101°; XV, first operation, $101\frac{3}{5}$°, second, $102\frac{3}{5}$°; XVII, $102\frac{3}{5}$°.

Of the fatal cases, the highest temperature in the first twenty-four hours was (thyroidectomy) II, 104° F.; VIII, 102°; XI, $101\frac{3}{5}$°; (sympathectomy) XVI, 103°; XVIII, 106°, the temperature in all reaching even a higher point before death.

A careful study of each case at the time and thoughtful review since have failed to throw much light upon the causes of the catastrophe, or to disclose any signs which might serve to warn one that operation would be dangerous in any case. The condition of the eyes, the rapidity and character of the

pulse, and the nervousness, were all carefully considered; and yet no essential difference could be found between the cases which recovered and those which did not.

The only possible sign of warning which I have been able to discover lies in the condition of the kidneys.

In all of the five fatal cases a trace of albumen, or even a considerable quantity, with granular casts, was found in the urine after operation. But in only two of them was albumen found in the examinations made before operation. Of the cases which recovered, two (I and III) had the same changes in the urine after operation. Two others which recovered (IX and XV) had a trace of albumen with hyaline casts. All four of these cases had a marked reaction in temperature and other symptoms after the operation. The fact that the casts were granular in the worst cases proves that they were not due to the temporary irritation of the kidney; but the absence of albuminuria before the operation would indicate that the kidney was not very seriously diseased. The most that can be claimed for this sign is that the presence of even a trace of albumen in the urine is a sign that there would be especial danger of thyroid poisoning if an operation were undertaken. Yet in at least one such case (XIV) recovery followed, but after an alarming reaction. Kocher believes that any septic infection of the wound increases the danger of this condition. As I had no disturbances of wound healing further than the formation of a hæmatoma, I am unable to testify upon this point.

Three theories have been advanced to account for this thyroid poisoning or thyroidismus: 1. Nervous influences; 2. Absorption of toxic thyroid material, and 3. Absorption of toxic blood. It is, of course, possible to ascribe these marked and definite symptoms, forming such a typical picture of tachycardia, violent febrile movement, and peculiar nervous unrest and excitement, to a central functional disturbance like that commonly known as shock. Some years ago the writer (*Medical News*, June 24, 1899) pointed out that a sharp rise of temperature is apparently a common symptom of severe shock

after our prolonged modern operations. In favor of this view is the fact that such attacks are occasionally seen in patients with exophthalmic goitre under the influence of some great nervous excitement. One of my cases (XVIII) had been prepared for operation in the usual way (washing of the neck the previous evening, abstention from food, etc.); but two hours before the time set for the operation (2 P.M.), she had a sudden rise of temperature to 101° F., with flushed face and increased nervousness. The operation was postponed. The leucocytes at 6 P.M. were found to be 9000. During the night the temperature fell to normal, but rose to over 100° F. in the afternoon for two days afterwards. More than one of the cases showed a temperature of 100° F. or even 101° F. on admission to the hospital, subsiding more or less rapidly under treatment. The frequency of thyroidism after sympathectomy and in operations not involving the thyroid gland is also in favor of their nervous origin.

The most popular theory has been the supposed absorption of the juices or secretion of the thyroid gland. Some (Rehn) have stated that after thyroidectomy for ordinary goitre a rise of temperature was the rule. In my own practice, however, this is not more common than in other operations, and I am glad to find the extensive experience of Kocher corresponds with mine.

To avoid the absorption of these fluids, some have warned us not to be too energetic in our efforts of sterilizing the neck in these cases. But the rise of temperature occurs too late (operation usually fifteen to eighteen hours after sterilization) to be due to this supposed rough handling of the neck. Others advise very gentle manipulation of the gland during removal, and this precaution I have always taken. I have also tried various methods of dividing the isthmus, with the same object of avoiding the escape of fluids into the wound or leaving large portions of the gland tissue to be absorbed; but in vain. The symptoms developed in spite of every precaution. They seem also to be as common after sympathectomy, in which the gland is not touched, as after thyroidectomy.

Kocher has advanced the theory that the symptoms are due to autointoxication of the patient by absorption of blood effused in the wound cavity, as some have claimed that there are toxic substances in the blood of these patients. But it has not been proved that blood effused into the wound and reabsorbed is more poisonous than the same blood while it is still circulating in the vessels, and this theory does not explain at all the similar attacks without operation. It has also been stated that the urine of these patients is toxic. Dr. F. C. Wood, the pathologist of St. Luke's Hospital, kindly made some experiments with the urine obtained from Case XVIII after operation, injecting it into animals, but his results were negative.

In Kocher's and Jonnesco's published cases there appear to be very few instances of fatal thyroid poisoning,—none at all in Jonnesco's. I have carefully searched their reports for the reason why they did not meet with this serious complication.

A study of Kocher's cases reveals that in two of his four fatal cases there was a very marked reaction of Graves's symptoms "thyroidism" after the operation, although in one of these the death appears to have been due to cerebral embolism.

In twenty-nine operations limited to ligation of the thyroid arteries, thyroidism followed in seven cases, being slight in three, fatal in one case. In thirty-eight partial thyroidectomies, thyroidism followed in nine cases, being slight in four, fatal in one case,—the death by embolism just mentioned. In either form of operation, then, about one-quarter of the cases suffered from these symptoms. I have sought through the histories for evidence in regard to the condition of the kidneys in those cases with thyroidism, and find mention of a trace of albumen in the urine in only one case before operation. (The presence or absence of albumen after operation is not given in any case.) In three of the cases the condition of the urine is not given, including the two fatal cases. It is worthy of note that in the entire series of fifty-nine cases albuminuria was found only once, and then only a trace.

In regard to the question of anæsthesia, a general anæsthetic seems to have been employed only three times, and in every one marked thyroidism followed, two being the fatal cases. Febrile reactions followed operation in thirty-two cases, —the temperatures running from 37.8° to 40.8° C. (but, as a rule, lower than those I have observed), in nine cases being due to wound infection, and in one other case to pneumonia. One case with a temperature of 40.4° C. recovered with primary union.

The reports of Jonnesco's cases are not full enough to be very useful in this study, but in two or three cases symptoms of high fever, etc., apparently acute thyroidism, followed sympathectomy, but ended in recovery. Of Jonnesco's fourteen personal cases of bilateral sympathectomy the operation was done on both sides in one sitting in four cases, and a moderate reaction followed in two of these, the other ten cases having the nerve removed upon only one side at a time, and only one of these cases showing a reaction. The principal differences, then, that I find between the operations of these surgeons and those of the writer are in the anæsthesia and in the less frequency of the bilateral sympathectomy in one sitting.

Kocher employed cocaine hypodermically, and only in certain bad cases resorted to ether narcosis. It is interesting to note that he met with the severest reactions in these cases. In Jonnesco's report the anæsthetic is only mentioned once, when it is stated that chloroform was employed. Apparently general anæsthesia, not local, was used by him.

Does Kocher's use of cocaine anæsthesia explain his better results? In the absence of evidence, we must neglect Jonnesco's cases. It will be noted, however, that the reaction was observed in some of the cases in both series. It has been stated by some that cocaine is especially dangerous as an anæsthetic in cases of exophthalmic goitre, but Kocher's large experience proves that this idea is erroneous. As to chloroform, there is at least one death during sympathectomy (Faure, quoted by Balacescu) to be charged to it.

On the theory of poisoning by thyroid substances or toxic

blood, it seems unlikely that there would be any difference between local and general anæsthesia,—unless we add the fact noted above, that damaged kidneys increase the liability to thyroidism,—and then we might make the hypothesis that the ether impaired their function so much as to prevent them from eliminating these toxic substances.

On the theory that the symptoms are due to shock, this difference might be more easily explained, as it must be admitted that in such operations as thyroidectomy general anæsthesia tends to increase the shock.

I have employed local cocaine anæsthesia in thyroidectomies for ordinary goitre with excellent results, but hitherto have hesitated to use it in operations upon patients with exophthalmic goitre because I feared the effect upon the heart. But hereafter I shall make a trial of it in these cases also.

Recently I have used the suggestion of Holland, of San Francisco, to anæsthetize the middle branch of the superficial cervical nerve with cocaine, and so gain sufficient anæsthesia to permit of thyroidectomy with only three or four drops of 2 per cent. solution of cocaine. The results have been excellent, and I hope to use a similar method for sympathectomy. If this can be done, we shall be able to gain complete anæsthesia with such a small amount of cocaine that there will be no danger from that source.

I have also thoroughly considered differences in technique which might affect the results, differences which might increase shock (by unduly prolonging the operation) or tend to the formation of hæmatoma in the wound. In this connection I can only plead that methods which did not usually have this effect when employed in other operations should have been satisfactory also in these. Further, the total absence of disturbances in wound healing is evidence that the technique was not bad. The majority of the operations were not unduly prolonged, although a few were tedious, and in most of them there were no marked symptoms of shock at the conclusion of the operation.

The second point noted above was the fact that in ten out

of his fourteen cases, Jonnesco divided the operation of sympathectomy into two stages; and it now seems to the writer that Jonnesco's freedom from the complication of thyroidism may have been due to this caution. In defence of his own choice for doing both sides at once, the writer would state that he formerly held the view very generally advocated up to the present that the symptoms were due to toxæmia, and therefore did not realize the importance of minimizing shock. Also, that in all but one of his cases the patient appeared to be in as good condition at the time of beginning removal of the second nerve as at any time. Usually the pulse and general condition improved when one nerve had been excised. Finally, he found it of great assistance in the dissection to make both incisions immediately at the beginning of the operation, dividing the deep fascia, because the goitre was thus rendered much more movable and the patient's breathing was improved. In addition, the patients generally rebelled at the idea of being submitted to operation twice. In the light of the experience and study just completed, the writer believes that, in spite of these reasons, for the present it will be wiser to divide the operation into two parts.

SUMMARY.

Remarks.—Exophthalmic goitre can be cured both by thyroidectomy and by sympathectomy. A perfect result can be expected in about 60 per cent. of the cases of thyroidectomy. An immediately good result appears to be the rule in sympathectomy. Sufficient time has not elapsed to judge of the permanence of the cure, but the immediate results of sympathectomy are far superior to those of thyroidectomy.

Mortality.—The relative mortality of the two would also seem to favor sympathectomy (Kocher, four deaths in fifty-nine cases of thyroidectomy or ligature only, Jonnesco none in fourteen bilateral sympathectomy); although in my own cases the proportion is the opposite. There is serious danger of fatal acute thyroidism after both operations.

Technique.—It appears to the writer wise to use local cocaine anæsthesia for thyroidectomy, and to give it a trial also

in sympathectomy. Sympathectomy should be performed upon only one side at a time, with an interval between the operations sufficiently long to permit the patient to recover from the effect of the first operation.

HISTORIES OF CASES.

CASE I.—Louise E., twenty-four years; single; New York; saleswoman. St. Luke's Hospital, August 11, 1893. Referred by Dr. J. A. Booth.* Family history negative. Personal history negative. Menstruation began at fourteen years, regular, normal. Seven years ago had a high fever lasting three weeks, supposed malarial. Three years ago noticed swelling in neck, and her eyes became prominent. Goitre increased slowly until ten months ago, then neck measured thirteen and one-half inches; was treated with electricity, reducing size of goitre, but not improving eyes. A little over one year ago noticed palpitation and rapid heart action, which are not so bad now as at first. At about the same time menstruation ceased for five months.

Examination.—Patient is very nervous; marked exophthalmos; thyroid gland much enlarged, chiefly on right side, but involving both lobes. Marked pulsation in carotids. The thyroid mass is not cystic; it is firm. The right border overlaps the right sternomastoid, the left does not reach the left sternomastoid. Neck measures thirteen inches at most prominent part of mass. Heart action tumultuous, rapid (pulse 142), apex beat normal, no murmurs. Lungs negative, respiration rapid (24 to the minute). Temperature, 100° F. Urine acid, 1023, faint trace albumen, no sugar, leucocytes, mucus.

Treatment.—Tr. digitalis, minims viii, sodium bromide, potassium bromide, āā gr. v, t. i. d.

November 11, 1893.—Ether narcosis. Angular incision, median below, diverging to right above, over thyroid. Vessels of right side dissected and ligated. Gland drawn out. Accessory lobe found at lower angle and removed. Isthmus ligated and right

* Some of these cases have been reported by Dr. J. A. Booth, "A Contribution to the Radical Cure of Exophthalmic Goitre, with the Ultimate Results in Eight Cases treated by Thyroidectomy," Journal of Nervous and Mental Diseases, September, 1902.

half of thyroid removed. Wound dry. Sutured with catgut. No drain. Sterilized gauze dressing and starch bandage. Pulse at end of operation 180, irregular and intermittent. Restless; quieted with Magendie. Temperature before operation two days between 99.4° and 100° F. (mouth), four hours after operation, 102.6° F. (rectal), falling steadily to 99.6° F. twelve hours later. For three days ran from 99.4° to 101.4° F., with regular afternoon rise. Thence onward from 98° to 100° F., becoming normal.

Pulse.—Before operation 110 to 142, four hours after operation 172. With low temperature next morning it was only 108, and then for three days it ran from 122 to 140, except on two occasions, 170 and 160. Followed temperature and settled to a rate of between 90 and 120 on discharge. Respiration remained about the same (20 to 24), except with the high temperature, when it reached 28 to 30 per minute.

No digitalis given after operation (intermittent pulse), but bromides continued.

Urine contained 8 per cent. albumen, with hyaline casts and epithelium, the day after operation; but the following day there was only 1 per cent. albumen, and none afterwards.

Except for her restlessness and some nausea and pain in the throat she seemed well. Primary union followed. She was allowed up November 22, and walked next day without any increase in the tachycardia. The eyes showed beginning recession. Discharged November 27.

1902, eight and one-half years after operation. "For the past six years has been employed in one of the large department stores, being on her feet most of the time from eight o'clock in the morning until six at night, not missing a day from her work, and during this period she has not been disturbed by any of her former symptoms. . . . The prominence of the eyes is still present, but to a much less degree. . . . The tremor has disappeared. . . . She has no palpitation. . . . The pulse is 80. . . . I think we are justified in believing her cured." (Booth, *loc. cit.*)

Case II.—Nellie D., forty-two years; single; New York; seamstress. Admitted St. Luke's Hospital, September 26, 1894. Referred by Dr. J. A. Booth. Family history negative.

Personal History.—"Nervous prostration" when young, severe typhoid about twenty-five years of age, followed by "dropsy." Two years ago began to lose flesh and strength, suf-

fered from thirst, and passed large amounts of urine. During past year has been treated for diabetes, and has regained flesh and strength. Has had severe neuralgia, face and chest, during last fifteen years. Just before this began had fever, cough, and was supposed to have phthisis.

Present Trouble.—Thirteen years ago first noticed swelling of throat, which has increased gradually. Only lately has she suffered from palpitation and dyspnœa on exertion. For two years has noticed increasing prominence of the eyes and lachrymation. Some dysphagia from pressure of the thyroid tumor. Has always been nervous, much more so of late. Appetite good. Bowels regular.

Examination.—Occupying region of the thyroid gland is a three-lobed tumor, the central lobe as large as a small hen's egg, the left lobe the same size, and the right lobe three times as large, reaching nearly to the angle of the jaw and beyond the line of the sternomastoid muscle. The tumor is moderately soft, does not fluctuate or pulsate, follows motions of larynx on swallowing, is attached to the trachea, and is without adhesions elsewhere. The eyes are very markedly protruding. The right submaxillary gland is enlarged.

The heart apex beat is in fifth space, inside of the nipple line. The first sound is accentuated at the apex. The pulse is rapid (120), but regular. A systolic murmur can be heard over the enlarged thyroid.

Lungs normal, respiration 24 per minute.

Fine tremor present in the hands.

October 2. Operation. Ether narcosis. Incision, angular, over right half thyroid. Vessels ligated. Right half thyroid removed. Wound sutured.

October 3, 2 A.M. Very restless. Pulse 142, irregular, fair force. Bromide sodium.

6 A.M. Pulse 160, very weak. Strychnine, gr. $^1/_{60}$ hypodermically every hour until 9 A.M., then whiskey by mouth, two drachms every hour.

10.50 A.M. Tr. strophanthus, minims v, hypodermically.

11 A.M. Aconitine, gr. $^1/_{240}$ hypodermically.

Urine acid, 1025, trace of albumen, no sugar. Hyaline and granular casts. Epithelium.

1.15 P.M. Morphine (Magendie, minims vii), with atropine hypodermically.

2 P.M. Profuse perspiration.

4 P.M. Face slightly cyanosed.

5 P.M. Stop whiskey. Give strophanthus, tr., minims v, hypodermically every four hours.

4th, 12.30 A.M. Magendie and atropine.

6.15 A.M. Unable to speak. Pulse 174, weak, irregular. Whiskey, two drachms every half-hour.

8 A.M. Unconscious and still very restless.

October 4, 12.30 P.M. Pulse weaker. Very irregular.

3 P.M. Unable to swallow.

4.30 P.M. Dressing removed. No sign of infection. Reapplied dressing.

4.50 P.M. Nutrient enema, with whiskey.

5.10 P.M. Wet cups to chest. Urine scanty, acid, ½ per cent. albumen. Few casts.

5.45 P.M. Hot pack for three-quarters of an hour.

6.30 P.M. Strychnine sulphate, gr. $^1/_{40}$ given hypodermically without effect.

6.45 P.M. Patient dead. Temperature after death reached 109.4° F.

CASE III.—Susan B. H., forty-three years; married; United States; housewife. Admitted St. Luke's Hospital, September 10, 1894. Family history negative.

Personal History.—Pneumonia twenty years ago. Menstruation regular until goitre appeared, and since then during four years she did not menstruate during July to October in each year. Three children, last born five years ago. Perineorrhaphy performed four years ago.

Present trouble began twenty years ago, when she noticed swelling in her neck, choking sensation, and dysphagia. Eyes have always been prominent, but grew worse since goitre began. Severe palpitation of heart, dyspnœa on exertion, nervousness, all followed appearance of goitre. In last six months has lost flesh and strength. Local applications of iodine to goitre did not affect it. Appetite good. Bowels regular.

Examination.—A U-shaped tumor occupies region of thyroid gland, left lobe extending up to the level of the thyroid cartilage, right lobe being more prominent and reaching level of hyoid bone.

Lower border descends a little below the sternum. Tumor is firm, does not fluctuate or pulsate, and is attached to trachea. Dilated veins are seen and some superficial arteries can be felt.

Heart apex in fifth space, outside of nipple line, action rapid and very irregular, soft systolic murmur at apex. Lungs negative. Eyes very prominent, upper lids move with bulbs. Marked throbbing of carotids.

Urine acid, 1011, no albumen or sugar.

October 1. Pulse, 92 to 100; temperature, 97.4° to 98.6° F.

October 2. Ether narcosis. Oblique incision along right sternomastoid. Ligation of vessels. Excision right half thyroid gland. Suture.

October 3. Urine acid, faint trace albumen, no sugar, hyaline and granular casts. Patient very hoarse after operation.

8 A.M. Pulse irregular, 120, rather tense. Ext. digitalis fl., minims ii, every four hours.

October 4. Stop digitalis. Pulse still irregular and intermittent.

Urine 1020, acid, faint trace albumen, hyaline casts.

October 6. Hoarseness increased. Urine same. Wound dressed and sutures removed. Primary union beginning. Pulse better.

October 13. Laryngoscopic examination shows right vocal cord stationary in phonation.

October 15. Hoarseness less. Primary union. Discharged cured.

September, 1899. Five years after operation. Has been at hard work and feels well. Pulse 100. Nervousness almost gone. Eyes still prominent, but much improved.

CASE IV.—Amelia B., twenty-one years; single; German; domestic. Admitted St. Luke's Hospital, November 28, 1895.

Family History.—Mother died of phthisis.

Previous History.—Diphtheria when a child. Menstruation began at eighteen, regular, four-weekly type, lasts two to three days. Always healthy.

Present History.—Four months ago she felt movable, painful swelling, size of cherry, on left side of throat, causing pain in swallowing and talking. About a month later it grew to a pigeon's-egg size and could be seen, and has kept on growing

since. General health good. No dyspnœa. No noticeable change in eyes. Works as usual. Appetite good. Bowels regular.

Examination.—Patient well nourished, good color. Heart apex fifth space, inside of nipple line. Sounds muffled. Action rapid, but regular. Inguinal glands palpable. Left lateral lobe thyroid enlarged to size of duck's egg, smooth, elastic, non-pulsating, but lifted by great vessels. Slight enlargement right lobe. No exophthalmos. Pulse, 80; respiration, 24; temperature, 99° F.

Urine acid, 1026, no albumen or sugar. Microscopic epithelial cells.

November 29. Operation. Ether narcosis. Transverse incision. Left half thyroid gland removed, with small accessory lobe below it. Isthmus ligated with catgut and cut across. No drainage. Wound sutured. Recovered without nausea.

November 30, A.M. Temperature, 98.4° to 99° F.; P.M., 101° to 99.6° F.; pulse, A.M., 60 to 92; P.M., 100 to 90.

Urine acid, 1027, trace of albumen. Comfortable, except occasional pain in wound. Light diet.

December 1. Temperature, A.M., 100.4° to 101° F.; P.M., 101.4° to 100.8° F.; pulse, A.M., 96 to 104; P.M., 116 to 92. Menstruation sets in.

December 2. Temperature, A.M., 100.4° to 100° F.; P.M., 100.4° to 99.6° F.; pulse, A.M., 86 to 100; P.M., 100 to 88.

Dressing removed. No infection. Collodion applied. Allow up.

December 3 and thereafter, temperature, 98.4° to 99.2° F.; pulse, 100 to 88.

December 5 and thereafter, normal temperature.

December 10. Incised a small subcutaneous hæmatoma under scar. One drachm bloody serum.

December 12. Wound healed. Discharged.

Pathological Examination.—Gland finely cystic, alveoli filled with material staining in eosin lined with cubical cells. No papillary formation. No round-cell infiltration.

Patient was seen about six months after the operation. "She was perfectly well, the pulse being 74; no nervousness or insomnia." (Booth.)

CASE V.—Nellie C., seventeen years; single; United States.

Admitted St. Luke's Hospital, December 16, 1895. Referred by Dr. J. A. Booth. Family history negative.

Personal History.—Scarlatina and measles in childhood. When six years old badly frightened by attempt made by her sister to throw her from a window, and "brain fever" followed, lasting two months. Always hyperidrosis of hands and feet. Menstruation normal. When twelve noticed swelling of upper eyelids. Eyesight good. Some nervousness and palpitation, coming on without exertion.

Present History.—Two or three weeks ago was told she had Graves's disease. Since then has had feeling of pressure on throat and suffocation. Dizziness on standing. Appetite good. Bowels regular.

Examination.—Well nourished. Good color. Considerable exophthalmos both sides. Marked œdema both upper lids, especially left. Eyelids follow globes. Heart apex fifth space, inside of nipple line. Action a little rapid (90 to 100), forcible. No murmurs. Thyroid gland enlarged, slightly more on the left. Normal consistency. Urine acid, 1015, faint trace albumen, no sugar. Microscopic examination negative.

December 17. Ether narcosis. Incision three to four inches long, transverse. Right lobe thyroid removed. Isthmus ligated with catgut. Sutured without drainage.

8 P.M. Temperature, 99° F.; 12, 100.6° F.; pulse, 94 to 104.

December 18. Temperature, A.M., 101.2° to 101.6° F.; P.M., 101.4° to 101° F.; pulse, A.M., 108 to 124; P.M., 120 to 108. Comfortable night with small dose morphine. Allowed fluids. Urine acid, 1032, trace albumen, no sugar, urates.

December 19. Temperature, A.M., 100.4° to 100.6° F.; P.M., 100.8° to 100.4° F.; pulse, A.M., 82 to 92; P.M., 112 to 88. Soft solids.

December 20. Temperature, A.M., 100° F.; P.M., 98.4° F., and normal thereafter; pulse, 100 to 84.

December 24. Primary union. Discharged.

Note.—"It is now seven years since the operation. There has been a complete disappearance of all nervousness; the throbbing and palpitation have ceased, and with two exceptions the pulse has not been above 90; no exophthalmos. The peculiar œdematous swelling of the eyelids still persists." (Booth.)

CASE VI.—Addie T., thirty-five years; married; United

States. Admitted New York Infirmary for Women and Children, January 10, 1896.

Family History.—Father was killed. Mother died of pneumonia. One sister died of exophthalmic goitre, and another sister also has the disease.

Personal History.—Always well as a child, scarlet fever when eight years old. Was kept in-doors as a girl. Menstruation began at thirteen years, natural. Married at twenty-one years, has had two children, last ten years ago. Immediately after birth of last child noticed swelling in neck, which grew rapidly for two weeks, and since then has remained stationary. Of late years has had rheumatism and indigestion.

Present History.—Since first noticed, the swelling in the neck throbs, but gives no pain, except some "dragging" in swallowing. Her heart throbs with every exertion. Frequent micturition, with some local irritation.

Examination.—Large goitre, especially on left side; firm, pulsating, size of a large goose-egg. No exophthalmos, but eyelids do not follow eyes downward. Decided tremor of fingers. Pulse regular, 110 to 130. No cardiac murmur.

January 11. Operation. Ether anæsthesia. A longitudinal incision, three inches long, was made over the enlarged left lobe of the thyroid gland, and another extending from this transversely towards the median line. The vessels were ligated, and found rather large and numerous. The left half of the thyroid gland was removed. Sutured by subepidermal continuous stitch of fine catgut. No drainage. Pulse fell to 90 during operation. Recovered from anæsthesia with nausea.

8 P.M. Temperature, 98.2° F.; pulse, 94; respiration, 22.

January 12, A.M., temperature, 98.8° F.; pulse, 84; respiration, 24; P.M., temperature, 101.4° F.; pulse, 120; respiration, 24.

January 13. Slept poorly. Complains of pain in heart. Temperature, 100.2° to 101.2° F.; pulse, 100 to 104, regular and strong.

January 14. Wound dressed. No infection. Complains of hot and cold "flashes" and of throbbing all over.

January 15. Highest temperature, 100.8° F.; pulse, 112.

January 16. 5 P.M., temperature, 100.6° F.; pulse, 92 to 112.

January 17. Sat up six hours. Feels well. Pulse, 92 to 108; temperature, 100° F., highest.

January 18 and thereafter. Temperature normal.

January 20. Some bloody serum escaped from wound yesterday and to-day. No pus.

January 22. Wound healed. Pulse, 72 to 84.

January 23. Pulse, 80 to 82.

January 24. Pulse, 80 to 96.

January 25. Pulse, 72. Patient is better every way. Feels much less nervous. Discharged.

Patient examined in October, 1897, and again about two years after the operation. "All nervous symptoms had disappeared, there had been no tachycardia, and the pulse was 84." (Booth.)

CASE VII.—Rose W., twenty-seven years; colored; single; domestic; United States. Admitted Post-Graduate Hospital, October 11, 1897.

Was in this hospital last summer for six weeks and was improved, but has grown worse since. Has tachycardia on exertion or excitement, not when at rest. Slight nervousness. Thyroid gland enlarged. Heart action regular and rapid. Loud bruit and thrill heard and felt in vessels of the neck. No murmur with heart sounds. Complains of "a lump" in the epigastrium. No tumor found there.

Urine, 1015 specific gravity, acid, no albumen or sugar. Temperature, 98° to 99.6° F.; pulse, 90 to 128, during October 11 and 12.

October 13. Before operation, temperature was 98.6° F.; pulse, 112.

2.15 P.M. Operation. Ether anæsthesia. Transverse incision. Superior and inferior thyroid vessels of right side and superior thyroid vessels of left side ligated. Right half and upper half of left half of gland removed, the gland tissue being divided by the thermocautery knife.

3.50. Returned to ward. Pulse 120, regular and strong. No nausea.

12 P.M. Temperature, 101° F.; pulse, 128. Beginning to be restless.

October 14, A.M., temperature, 100.6° F.; pulse, 132; P.M., temperature, 101° F.; pulse, 138. Urine, specific gravity 1020, acid, no albumen or sugar.

October 15. Slept well; A.M., temperature, 99.2° F.; pulse,

100; P.M., temperature, 100° F.; pulse, 108. Tinct. digitalis is given minims v. every four hours.

October 16, A.M., temperature, 99.2° F.; pulse, 112; P.M., temperature, 100° F.; pulse, 98.

October 19. There is a little hoarseness, but examination of larynx shows no paralysis of vocal cords.

October 21. Discharged. Wound healed. Condition improved.

Patient has not been seen since.

CASE VIII.—Mary E. F., thirty-four years; single; English; sick nurse. Admitted St. Luke's medical ward, August 13, 1896, transferred surgical ward, May 14, 1897. Referred by Dr. Mabbott. Family history negative.

Personal History.—Scarlatina as child. Diphtheria nine years ago. Typhoid fever four and a half years ago. Always delicate. Menstruation at fifteen years, irregular, two weeks to six months intervals, with pain, scanty.

Present trouble began about eight months ago, while attending patient with very bad exophthalmic goitre. Noticed she was getting very nervous, easily startled, palpitation, eyes gradually becoming prominent, profuse cold perspirations, great tremor of hands, lost flesh and strength. Passes very restless, wakeful nights. Has headache and gastric distress. No increase observed in size of neck.

Examination.—Eyes very prominent; upper lid does not follow bulb; patient has to scowl in order to completely close lids. Heart apex just inside nipple, in sixth space. Action regular, rapid, forcible. Systolic murmur over apex, transmitted into axilla, but loudest over base, especially at junction of sternum and left second space. Heard in right subclavicular fossa.

Lungs normal. Urine 1014, acid, negative. No enlargement of thyroid.

October 24. Has improved under sodium glycerophosphate and belladonna. Begin thymus extr., gr. v, t. i. d.

November 14, 1896. Examination by Dr. Kinnicutt. Moderate enlargement of thyroid, more on right side. Neck measures eleven and seven-eighths inches at greatest fulness. Pulse, 131 (rather worse than usual). Extremely nervous. Fine tremor of upper extremities, and lower also. Heart apex fifth space, within nipple line. Systolic murmur apex and base. Marked pulsation

carotids, which is communicated to thyroid. Exophthalmos of high grade in both eyes. Stellwag's and Graefe's signs exceptionally marked.

December 1. Increase thymus to gr. lx daily.

January 1, 1897. Patient thinks herself better, but there is no improvement.

Examination by Dr. K. Neck measures twelve and one-fourth inches.

February 5. Stop thymus.

February 22. Galvanism to both sympathetics.

March 22. Improved. Neck, twelve inches.

May 13. "Patient's condition has not changed in several months." Transferred to surgical service.

May 14. Urine acid, 1015, trace albumen, no sugar. Few blood-cells.

Ether narcosis, 11 A.M. Transverse incision over thyroid. Right superior thyroid vessels ligated. Middle thyroid veins, right inferior thyroid vein, corresponding artery ligated, last near carotid. Isthmus ligated with interlocking ligatures. Right half thyroid cut away and surface of stump seared with Pacquelin cautery. Sutured wound.

Went to bed with pulse 140, respiration 50, and recovered consciousness in forty minutes without nausea. Soon became very restless, and pulse and respiration quite irregular. Magendie, minims v, hypodermically. Complained of pain in eyes. Cocaine and cold compresses had little relief (pain in eyes was very frequent in this case throughout).

7 P.M. Restless. Sodium bromide by rectum without effect. Allowed to sit up in bed. Water hypodermically had some effect. Coughs a great deal, but without force. Sounds like laryngeal paresis. Takes fluids by mouth.

May 15, 6 A.M. Slept one hour. No nausea.

8 A.M. Pulse irregular, 160. Difficulty in swallowing.

10.15 A.M. Pulse, 170. Urine, 2 per cent. albumen. Granular casts.

12.15 P.M. Digitalin, gr. $^1/_{100}$ every four hours. Strychnine, gr. $^1/_{60}$ hypodermically given.

2 P.M. Whiskey, one drachm every two hours. Pulse very irregular and rapid. Respiration rapid and rather labored. Mind rather wandering, restless and talkative.

4.30 P.M. Potassium bromide, gr. xxx, per rectum. Very restless. Color cyanotic.

5.30 P.M. Pulse imperceptible. Failed, and died 6.40 P.M. Temperature, 106.2° F.

CASE IX.—Mabel C. C., eighteen years; single; United States. Admitted St. Luke's Hospital, December 7, 1896. Referred by Dr. J. A. Booth.

Had measles. Since twelve years of age has had headache and "biliousness" occasionally. Menstruation began at fourteen, rather irregular.

One year ago began to have attacks of diarrhœa, which have occurred about once a week. About two years ago noticed change in neck, and three months later became nervous and easily frightened, with palpitation and dyspnœa. Eighteen months ago was told she had exophthalmic goitre. She is far-sighted. Appetite good. Neck measures fourteen and one-half inches.

Ice-bag applied to heart region. Thymus administered. Aconitia, gr. $^1/_{200}$.

January 5, 1897. Heart apex in fifth space, inside mammillary line. Apex beat diffuse. Heart action rapid, regular, without murmurs.

January 28. Urine acid, 1024 specific gravity, no albumen, no sugar, no casts.

January 28. Ether anæsthesia. Transverse incision. Superior thyroid vessels tied on right side. Inferior thyroid tied close to gland. Right half thyroid dissected out, isthmus tied with silk ligature, divided, and stump cauterized. At end of operation, pulse 200, but forcible. Much pain in wound. Restless. Nauseated.

January 29. Urine acid, specific gravity 1032, trace of albumen, no sugar, hyaline casts. Patient very restless, nauseated, pain rather less.

January 30. About same. Wound opened and cloudy, bloody serum evacuated. Small drain-tube inserted. More comfortable after this.

February 1. Better.

February 3. Severe headache.

February 19. Wound healed by primary union, except at drain.

January 12, 1899. Readmitted. Some improvement fol-

lowed operation, but lately she has grown worse again. Pulse more rapid, some dyspnœa, exophthalmos more marked. Respiration, 32; pulse, 100; temperature, 99.6° F. on admission.

Marked pulsation is felt in left superior thyroid artery, with a thrill. Ether anæsthesia. Artery easily exposed and ligated.

Temperature did not rise above 100° F. Pulse ran up to 120, gradually falling to 96 or 100. She was very restless and noisy, nauseated, and complained of pain immediately after operation. Had headache during stay in hospital. Primary union of wound. Discharged January 17.

Note.—"When I saw her on May 8, 1902, the eyes were not so prominent; the remaining lobe of the thyroid was smaller; the nervousness was less; she was seldom disturbed by palpitation, and the pulse was 100." (Booth.)

Case X.—Mary E. McK., thirty-six years; single; United States; bookkeeper. Admitted St. Luke's Hospital, October 27, 1897. Referred by Dr. J. A. Booth.

Family History.—"Consumption."

Personal History.—Negative.

Present trouble began ten months ago with malaise, nervousness, beginning prominence of eyes. Has always had a rapid heart and noticed no change there. Patient became so nervous she had to give up her work. Goitre not marked. Appetite good. Bowels loose.

October 27 to November 13. Pulse began at 130 and was reduced to 100 to 110. Respiration ran from 22 to 26. Temperature, 98° to 99.2° F.

November 13. Ether narcosis. Transverse incision. Vessels ligated. Isthmus divided by cautery without ligature. Left half of thyroid removed. No drain. Wound sutured. Pulse rapid, 160, but good force. No nausea. Restless.

November 14. Feels well. No pain. Face flushed, and very thirsty.

November 19. Sitting up. Much improved.

November 14. Temperature, 101.4° F. all day. Fell at night to 98.5° F.

November 15. Rose at midday to 101° F., but soon fell, and remained below 100° F.

Pulse 150 to 160 while temperature was high, then fell to 120 to 130. November 17 fell below 120, and ran from 100 to 110 until discharged.

November 24. Discharged. Primary union. Great improvement.

Note.—"When seen on April 26, 1902 (four and one-half years after operation), she stated that she had been very much improved in every way. She is less nervous, sleeps as well as ever. She is now able to write and keep her books neatly; formerly she was not able to do this because of the tremor. She has hardly any palpitation now, and the pulse varies from 80 to 90. Prominence of eyes hardly noticeable." (Booth.) Patient works as cashier, where she has considerable responsibility and need of haste, which appeared to be the original cause of her disease.

CASE XI.—Annie S., twenty-three years; single; United States; saleswoman. Admitted General Memorial Hospital, April 13, 1898. Weight, 110 pounds. Height medium. Referred by Dr. Leszynsky.

Health good previous to present trouble. First menstruation at seventeen years, irregular always, amount slight. Has had measles. Some chronic throat trouble, with enlarged tonsils. Had one bad attack of intermittent malarial fever. Had rheumatism two years ago in one ankle.

Five years ago noticed a small swelling in thyroid region, which has rapidly increased during last two years. About two years ago noticed rapidity of pulse and has had much palpitation. Heart seems to shake entire body with its forcible pulsation. Has attacks of dyspnœa on exertion. Throbbing of vessels in neck is very annoying. Has been growing very nervous in last two years, restless, but sleeps well. No headache except when throat is sore. Hyperidrosis is present. For three years eyes have been observed to be growing prominent. For last year has been near-sighted and the eyes remain open during sleep, as it is an effort to keep the lids closed. Lachrymation. Appetite good, but tendency to diarrhœa of late. Tremor of hands during last year; sometimes all her limbs shake so that she can hardly stand.

Examination.—Exophthalmos quite marked, left eye more prominent than right. When asleep, the eyes are one-third open. Upper lid does not follow eyeball in looking down. No nystagmus. There is reduction of convergence. No ophthalmoscopic changes in retina. Thyroid gland enlarged, right lobe to size of turkey's egg, left to hen's egg size. A thrill is felt on right side,

and tumor has pulsation transmitted from the vessels of the neck. Venous hum heard in veins of neck.

Heart-dulness increased. Systolic thrill at apex. Systolic murmur, blowing in character, over pulmonary valve, transmitted upward. Heart action exaggerated.

April 23, 1898. Pulse, 28; respiration, 22; temperature, 98.6° F. Ether anæsthesia. Transverse incision. Right lobe freed and vessels tied. Free oozing from veins on surface of tumor controlled by gauze applied firmly around it. The isthmus was divided with the thermocautery. The tumor of the right lobe was removed; it was very vascular. The inferior thyroid artery of the left side was then ligated. Suture of wound. No drain. Time of operation sixty-five minutes. Patient in good condition.

April 23, 9 P.M. Pulse, 174; respiration, 40; temperature, 98° F.

April 24, 2 A.M. Pulse, 136; respiration, 50; temperature, 100° F.

6 A.M. Pulse, 168; respiration, 36; temperature, 100° F.

10 A.M. Respiration, 40; temperature, 101.6° F.

2 P.M. Pulmonary œdema. Respiration, 40; temperature, 100.2° F.

6 P.M. Respiration, 45; temperature, 100.6° F.

10 P.M. Respiration, 60; temperature, 104.2° F.

April 25. Died at 3.20 A.M. Temperature, 106.4° F.

Albuminuria and suppression of urine after operation.

CASE XII.—Mary F., twenty-five years; married; Ireland; housewife; 66 First Street. Admitted Bellevue Hospital, May 12, 1899. Referred by Dr. Theodore Janeway. Family history negative.

Past History.—Has always been subject to attacks of headache and diarrhœa. Has had three children, last one a miscarriage, two and one-half years ago. Was never injured.

Present History.—Two years ago first noticed a soft, movable lump in right side of neck just above the collar-bone, about the size of a marble. At this time was troubled a great deal with a sore throat and severe headache. Lump gradually increased in size, was never painful or tender. Six months later a similar lump appeared at same place on the left side of neck; these have increased in size. A year ago patient's friends noticed eyes were beginning to protrude and pupils were larger. Has been troubled

with shortness of breath and pains in knees, especially when climbing stairs. Patient has gradually become very nervous.

Examination.—Shows thyroid gland enlarged, more especially on the right side, about size of hen's egg; the left a trifle smaller, not painful or tender; eyes are staring and slightly protruding, pupils dilated and respond to light and accommodation. Patient is very nervous, easily frightened. Heart beats between 76 and 88 per minute, but soon quickens when patient walks about or when frightened.

Heart beats are strong, murmur at apex transmitted to axilla, a murmur to right of sternum.

Lungs normal.

Urinalysis negative.

Operated upon May 17, 1899. Ether narcosis. Incision made five inches long in right side of neck, over posterior border of the sternocleidomastoid muscle, and carried slightly forward. With great difficulty the sympathetic nerve was found. In doing so, the sheath of the jugular vein was opened. The external jugular vein was ligated. About four and one-half inches of sympathetic nerve were removed, with the middle and inferior ganglion. The ether began at 2.20 P.M. During operation the pulse varied between 90 and 96; before operation, pulse was 88. No change while cutting the nerve. While closing the wound with fine silk sutures, pulse was 100 and not so full. Operation on the right side finished at 3.55. Incision made the same way on left side. Nerve found and removed, together with the middle and inferior ganglion. During the operation on left side pulse was 110 to 120, varying in quality; after excision of nerve weaker and more rapid, running up to 140. Strychnine, gr. $^1/_{30}$; atropine, gr. $^1/_{120}$, given. Pulse dropped to 125. Wound closed with small silk sutures. Operation finished at 4.15. Time of first operation, one hour and thirty-five minutes; of second, twenty minutes. At 9 P. M., temperature, 99.8° F.; pulse, 82; respiration, 24.

May 18. Patient complains of pain over heart. Temperature, 100° F.; pulse, 102; respiration, 28, at 9 A.M.

May 20. Wound dressed, healing with primary intention. Every second suture was removed. Pain around heart has disappeared. Temperature, 99.4° F.; pulse, 80; respiration, 20. Patient feels much better to-day.

May 27. Wound entirely healed. Patient comfortable.

Tumor in right side of neck is smaller and firmer; left side has not changed. Discharged May 29, 1899, cured.

Note.—Patient was last seen about a year after the operation. The tremor and nervousness had much improved. The goitre was somewhat smaller. The pulse was about the same. There were marked and apparently increasing murmurs about the heart. The eyes were practically normal.

Case XIII.—Clara R., twenty years; single; United States; dressmaker. Admitted St. Luke's Hospital, September 24, 1902. Referred by Dr. W. B. Noyes. Family history negative.

Previous History.—Had measles. First menstruation at fifteen, regular until eight months ago, when present trouble began. Always well and strong previous to present trouble, when she first noticed small swelling on right side of neck, which slowly increased. At the same time her eyes became prominent, and she began to lose strength. Has lost thirty-five pounds. She developed tremor of the hands and lips, and became very nervous. Her heart beats very fast and palpitates at times. Hyperidrosis of hands and feet. Menstruation very irregular, coming only four times since last January, the last time in July. Has been unable to work. Appetite good. Bowels regular. Sleeps well.

Examination.—Patient of small frame, poorly nourished, extremely nervous. Eyes very prominent and restless. Pupils equally dilated. Lungs negative. Pulsation of heart felt over entire precordium, apex beat in sixth intercostal space in the nipple line. Pulse rapid, forcible, regular. A loud, blowing systolic murmur can be heard with first sound, most marked at apex, and also distinct over the aortic valve. Thyroid gland uniformly enlarged, U-shaped, each lateral lobe equally enlarged and of the size of an orange. The gland is soft and can be reduced in size by pressure. There is a well-marked thrill at the upper end of each lobe. A harsh blowing systolic sound can be heard over entire tumor, and extending down on the chest below the clavicle and upward on each side to the mastoid processes.

Urine acid, 1022, faint trace of albumen, no sugar. Microscopical examination negative. Tinct. aconite, minim i, every two hours during day. Sodium bromide, gr. v, t. i. d., after meals.

September 30. Hæmoglobin, 70 per cent.

Urine acid, 1020, marked trace of albumen, no sugar. Microscopical. A few hyaline casts.

1.50 P.M. To operating room. Pulse, 120; respiration, 30.

September 30, 2.25 P.M. Nitrous oxide gas administered, followed by ether. 2.50 P.M. operation began. Incision made along posterior border of left sternomastoid, from mastoid process to clavicle. Sternomastoid drawn towards median line, carotid and vein exposed and drawn inward and forward, and the sympathetic nerve found without difficulty. Very little bleeding, although all the vessels were distended. The uppermost ganglion exposed by blunt dissection, a Kocher clamp put on its upper end, and the nerve torn across above this by twisting. The nerve was then dissected out, the inferior thyroid artery being divided between two ligatures, and the middle and inferior ganglia removed with it, the nerve being cut with scissors. During the twisting out of the upper end, the left pupil was in a state of hippus and irregular in outline. The wound was left open and the operation continued. The pulse was rapid, but of good force. The respiration rapid and superficial, and the surface somewhat cyanotic. Practically no anæsthetic was given after the first half of the operation. The right nerve was removed in a similar manner, but more rapidly, as there were fewer vessels on that side. Just after the nerve was removed (about 4 P.M.), the patient suddenly ceased breathing. The heart continued to beat, and artificial respiration was tried by the Sylvester method and with the Fell-O'Dwyer apparatus. Strychnine and oxygen were administered, but the heart soon ceased to beat, and the patient was dead. There was considerable tenacious, frothy mucus coughed up during the operation, and it seemed probable that the smaller bronchi had become filled with it. There was no obstruction in the upper air passages.

CASE XIV.—Maggie B., twenty-eight years; single; Ireland; domestic. Admitted St. Luke's Hospital, November 26, 1902. Family history negative.

Personal History.—Has had scarlet fever and diphtheria, otherwise well until present trouble began four years ago. First menstruation at twelve, regular, three-weekly type; dysmenorrhœa. Three years ago exploratory laparotomy done; does not know what was found. About four years ago noticed peculiar gurgling in throat, and a little later neck began to swell. A year later she could feel a mass in front of the neck. Last winter was told her eyes were prominent. Has pain in back and chest and

over the liver, which "swells." Feels very nervous. Heart palpitates. Has frequent headaches. Bowels constipated, but for last year has incomplete control of sphincter ani. Has lost flesh and strength. Has been under treatment lately in medical wards without improvement.

Examination.—Poorly nourished. Moderate exophthalmos. Eyelid does not follow bulb in looking down. Pupils equal and react to light and accommodation. The thyroid gland is enlarged, forming a tumor the size of a small orange, most prominent in the mid-line, extending somewhat farther to the right than to the left. Marked pulsation in the carotids. No thrill or bruit in the tumor, but it seems to pulsate slightly. Apex beat in fifth space, three and one-half inches from mid-line, and slight impulse felt all over precordium. A soft blowing systolic murmur is heard at the apex, transmitted towards mid-line. In second left intercostal space a loud systolic murmur is heard, which is not transmitted into the cervical vessels. The aortic sounds are normal. Lungs negative. Well-marked tremor of fingers.

November 26 to December 2. Temperature, 98.5° to 99° F.; pulse, 92 to 112. Hæmoglobin, 80 per cent. Urine acid, 1012, no albumen, no sugar. Aconite, strychnine. Ice-bag to heart.

December 2, 1902. Ether narcosis. Bilateral cervical total sympathectomy. Incisions along anterior border sternomastoid muscle from angle of jaw to sternum. Some hypertrophied lymph glands were in the way and were dissected out. Left sympathetic nerve dissected out and clamped at upper pole of superior ganglion. This caused immediate contraction of left pupil, followed by dilatation, irregularity, and, finally, contraction. The movements of the pupil were not extreme. Upper end twisted out. Entire nerve removed, with all three ganglia. Right nerve removed in same way, with similar effect on the right pupil. No alteration of pulse or respiration when nerves were severed below with scissors. Anæsthesia was maintained very slightly. No mucus in throat. Wounds closed with fine silk sutures and no drain. Operation lasted one hour and forty-five minutes. Pulse, 120; respiration, 26 at beginning of anæsthesia; 108 and 36 when patient was sent to the ward at 6 P.M.

8 P.M. Temperature, 99.6° F.; 12 P.M., 101.8° F.; pulse, 108.

December 3, 4 A.M. Temperature, 100.4° F. in rectum (pulse,

114), never rose above 101° F., and fell to 100° F., December 5, to remain down thereafter. Improvement in eyes already.

Pulse, December 3, 138 to 108; 4, 112 to 106; 5, 106 to 80; 6, 94 to 80; remaining thereafter between 90 and 100, even when she first left the bed.

December 15. Primary union of wounds. Thyroid and exophthalmic improvement marked. Patient less nervous.

December 22. Discharged. Eyes normal. Tremor very slight. Heart action regular and of good force. Murmurs less distinct. Feels much better.

Case XV.—Ella F., twenty-three years; single; domestic; United States. Admitted St. Luke's Hospital, November 27, 1902. Referred by Dr. T. D. Wood. Family history negative.

Personal History.—Measles and whooping-cough in childhood. Diphtheria one year ago. Soon after was operated on, thyroidectomy right half, in another hospital. First menstruation at seventeen, always irregular, from two to eight weeks interval, and last year went eight months without menstruating.

About two years ago noticed prominence of eyes and swelling of neck. Gradual increase since. Has many nervous symptoms,—irritability, flushing of face, trembling hands. These improved somewhat after operation, but she is now as bad as before. Appetite good. Bowels regular. Last menstruation two weeks ago. Feels weak and has dyspnœa on exertion.

Examination.—Moderately well nourished. Under medium size. Moderate erythema of face. Very marked exophthalmos. Pupils moderately dilated, react to light and accommodation. Upper lid does not follow bulb in looking down. There is a horizontal scar from the right thyroidectomy. The left lobe of the thyroid remains, enlarged, size of a hen's egg. No bruit or thrill or pulsation in the tumor. Marked pulsation of vessels of neck.

Forcible impulse over entire precordium. Apex beat in fifth intercostal space in the mammary line. Heart sounds normal. No murmurs, except a soft, blowing systolic murmur in second left intercostal space, transmitted upward in the neck on that side. Lungs normal. Moderate tremor of the fingers.

November 27 to December 2. Temperature from 98.5° to 99.8° F.; pulse, 110 to 140 (reduced by rest in bed, ice-bag to heart, bromide, aconite); respiration, 24 to 30.

Hæmoglobin, 100 per cent. Urine acid, 1030, no albumen, no sugar, but many casts were found.

December 2. Before operation, pulse, 152; respiration, 26. Leucocytes, 7200. Ether anæsthesia. Incision along internal border left sternomastoid. Left sympathetic nerve dissected out after removal of an enlarged lymph node. Kocher's clamp placed on nerve above superior ganglion and nerve avulsed. Nerve accidentally divided just above the inferior ganglion, and the latter seized with a Kocher clamp and twisted out. Suture (fine silk), without drainage. Duration of operation just one hour, fully twenty minutes being devoted to accurate suture after anæsthetic was suspended. When nerve was divided above, the pupil dilated, became irregular, and then contracted. Patient's pulse remained good. Some cyanosis and some tenacious mucus in throat, which required constant sponging. At end of operation, pulse, 130, good force; temperature (rectal), 99° F.; respiration, 24. Slight nausea. Later had some pain.

December 3. Urine 1030, acid, many hyaline casts. Leucocytes, 15,800 at noon. Saline enemata have been given. Now aconite, sodium bromide, strychnine sulphate, and ice-bag to precordium are resumed. Fairly comfortable day.

December 6. All sutures removed.

December 11. Primary union of wound.

December 19. Hæmoglobin, 100 per cent.

Urine acid, 1020, no albumen, no casts. Before operation, pulse, 98; respiration, 26. Nitrous oxide anæsthesia, followed by ether. Right sympathetic nerve removed by same method. Pupil dilated when nerve was severed; no irregularity occurred, however, and contraction followed slowly. The operation required ninety minutes, being prolonged by trying to dissect out the inferior ganglion first, but its recognition was found to be very difficult. A considerable vessel was injured, so that the former method was reverted to and the operation then easily completed. At end of operation, temperature, 98.6° F.; pulse, 144; respiration, 40. Slight nausea. Very restless.

December 20. Very restless and thirsty all day. Wound dressed and several drachms of blood allowed to escape from it; rubber tissue drains inserted. Urine acid, 1022, trace of albumen, no casts. Bromide of sodium.

December 21. Still restless. Aconite resumed.

December 22. More comfortable.

December 24. Sutures removed.

January 8, 1903. Discharged. Less nervousness and tremor. Pulse slower, about 100. Eyes very much less prominent, especially the left.

April 20. Examined. Patient looks well and feels much improved. She is doing her full work as chamber-maid. Still has some dyspnœa on exertion; breathing with mouth shut is difficult, some obstruction in left nostril. Neck measures twelve to twelve and one-quarter inches in circumference, and the remaining half of the thyroid is much smaller. The scars are pink and rather wide. Pulse 120, regular, normal in tension after walking to office and under slight excitement. Heart action much less tumultuous. Eyes much improved since last seen. Eyelids follow globes promptly in looking down. Pupils not unusually contracted. Flushing of face less marked. Slight restlessness of manner. Sleeps well. Eats well. Bowels regular. The outspread fingers are held steady, practically without tremor.

The left eye is no more noticeable than an extremely myopic eye. The right eye protrudes more, especially in looking down.

Patient has headaches, but had them before operation,—dull, throbbing, sometimes severe enough to prevent her from working.

CASE XVI.—John J. G., twenty-three years; single; United States; Hebrew; clerk. Admitted St. Luke's Hospital, January 10, 1903.

Family History.—Negative, tuberculosis.

Personal History.—Muscular rheumatism seven years ago, gonorrhœa six years ago, and twice since. Alcoholic habit since fifteen years old. Moderate smoker. Excessive masturbation.

Present History.—Six years ago was first told that his neck was swollen and his eyes protruding. He felt rapid heart action and palpitation. Was treated once with thyroid extract and rendered worse. Has always been nervous. Does not think he is any worse than at first, except that the goitre has increased; yet in the last three months the latter has slightly decreased. Has general weakness, attacks of dyspnœa on exertion, bowels are irregular, and appetite poor.

Examination.—Medium frame. Moderate exophthalmos both eyes, pupils equal, reacting sluggishly to light and accommodation. Stellwag's and Graefe's signs not present. Marked visi-

ble pulsation of vessels of neck. Thyroid gland markedly enlarged, nearly uniformly. Pulse rapid (138), good force. Heart apex in fifth intercostal space, five inches from mid-line, impulse diffuse and heaving. Faint systolic murmur at apex, transmitted short distance into axilla, and heard over base also. Lungs negative. Coarse tremor of hands.

January 10 to 15. Pulse, 88 to 102 since admission; temperature, 98° to 99.4° F.; respiration, 24 to 36. Urine acid, 1020, no albumen, sugar, or casts. Aconite, sodium bromide; ice-bag to heart.

January 15, 1903. 2.10 to operating room. Pulse, 120; respiration, 28. Ether narcosis, preceded by nitrous oxide. Attempt made to find superior left sympathetic ganglion by posterior incision and failed. Incision then made at anterior border sternomastoid. Nerve found and removed in usual manner, except that the incision was united to posterior incision by a transverse cut at its upper angle, and skin dissected up to allow access in front of sternomastoid towards angle of jaw. The left pupil was already much contracted and no change followed avulsion of the nerve. All three ganglia and the entire nerve were removed. The wound was sutured, and then the right nerve and all three ganglia (the lowest intimately combined with the first dorsal ganglion) removed by the usual method,—incision along anterior border of sternomastoid. The greatly dilated internal jugular vein was a source of great difficulty in reaching and identifying the nerve. Avulsion of the nerve caused no change in the contracted pupil. A drain was placed in the left wound. The operation lasted over two hours, but the patient bore it apparently well. There was the usual tenacious mucus in the throat. The pupils remained remarkably contracted throughout. Pulse at end of operation, 164; irregular, fair force. Respiration, 38. Regained consciousness very rapidly.

January 15, 5.50 P.M. Conscious. No nausea.

6 P.M. Saline enema.

7 P.M. Saline enema.

7.30 P.M. Very restless. Pulse 170, more regular.

8.10 P.M. Magendie, minims v, hypodermically. No effect.

9 P.M. Vomited brown fluid. Dressing stained with blood left side.

10 P.M. Aconite, minims iv, every two hours.

11 P.M. Sodium bromide, gr. xxx. Does not sleep. Urine acid, 1022, no albumen and casts.

January 16, 9 A.M. Sodium bromide, gr. xxx. No sleep. Vomited after bromide,—greenish. Epistaxis. Extreme restlessness.

2 P.M. Sodium bromide, gr. xxx, given every six hours.

2.20 P.M. Hyoscine hydrobromate, gr. $^1/_{100}$. Quieter.

3 P.M. Dressed, two sutures removed. Allow bed-rest. Magendie, minims v, hypodermically. Nutrient enemata every six hours.

6.30 P.M. Restless all day. Takes food well.

January 16, 8.30 P.M. Restless. Strychnine sulphate, gr. $^1/_{30}$, hypodermically.

11 P.M. Restless. Magendie, minims vi, hypodermically. Forty-eight fluidounces urine during twenty-four hours.

January 17, 2 A.M. Restless. Respiration labored. Alcohol sponge bath; good effect. Digitaline, gr. $^1/_{20}$, hypodermically, every two hours.

4 A.M. Pulse better.

6 A.M. Pulse rapid again. Restless. Hyoscine hydrobromate, gr. $^1/_{100}$, hypodermically. Slight effect.

12 noon. Throat examined. Apparent paralysis vocal cord. Urine 1022, acid, faint trace albumen, no sugar, granular casts. Nutrient enemata well borne until now; expelled.

2 P.M. Make digitaline every four hours.

3 P.M. Pulse, 188. Irrational. Whiskey.

6.30 P.M. Leucocytes, 6400.

7 P.M. Stop digitaline. Respiration labored.

9.20 P.M. Saline intravenous infusion 500 cubic centimetres.

10.30 P.M. Chill lasting five minutes. Pulse and respiration very rapid. Temperature, 106° to 107° F.

12 M. Profuse perspiration, extremities cold.

Urine in twenty-four hours, sixty-one fluidounces.

12.45 A.M. Hydrobromate hyoscine, gr. $^1/_{100}$, hypodermically. Very restless. Temporary effect.

January 18, 2 A.M. Quieter, sleeping.

3.25 A.M. Respiration suddenly became more labored, waking patient.

3.30 A.M. Died.

CASE XVII.—Lily W., twenty-six years; married; German;

housewife. Admitted St. Luke's Hospital, January 12, 1903. Referred by Dr. J. A. Booth. Family history negative.

Personal History.—Measles as a child. Diphtheria several years ago. Menstruation began at thirteen, regular until four years ago, when it ceased for eight months. Married two and a half years ago. One child born nine months ago, now dead. Goitre no worse during pregnancy.

Present History.—Four years ago was "sick" for several months and "ran down greatly," and then noticed protrusion of eyes and swelling of neck. The eyes remained about the same, the neck continued to enlarge. No palpitation of heart, except after exertion. Not very nervous. Appetite good. Bowels regular. Feels pretty well, but has pain in eyes, and thinks eyes and neck disfiguring.

Examination.—Patient medium height, large frame, well nourished. Very extreme exophthalmos, especially in left eye. The signs of Stellwag, von Graefe, and Moebius all present. Pupils react sluggishly to light, very well to accommodation. Tongue is tremulous. Thyroid gland much enlarged in three distinct lobes. Circumference of neck at most prominent part is sixteen and one-half inches. Tumor firm, not pulsating.

Apex beat in fifth intercostal space, five inches from mid-line. Faint, low-pitched murmur, presystolic, at the apex; and soft, blowing systolic murmur over the base. Pulse rapid (116), regular, good force.

Lungs negative. Moderate tremor of fingers. Urine 1024, acid, faint trace of albumen, no sugar, no casts.

January 12 to 17. Aconite, bromide; ice-bag to heart.

January 17. Hæmoglobin, 85 per cent. Before operation, pulse, 124; respiration, 24.

2 P.M. Ether narcosis, preceded by nitrous oxide. Both incisions made at once along anterior border sternomastoid, and skin and deep fascia divided to allow ready retraction of the large thyroid gland. The right sympathetic nerve with all three ganglia were first removed as usual, then the left. A small portion of the left superior ganglion was left behind. Both pupils were contracted throughout and no change was produced in them. The wounds were closed with interrupted, fine silk sutures without drainage. The anæsthetic was well borne, but the usual tenacious mucus required sponging. Very little ether was used. After

operation, temperature (rectal), 101° F.; pulse, 100; respiration, 24. At 8 P.M. temperature rose to 102.6° F. (pulse 106), but fell to 101.6° F. at 12, then to 100°, and there remained until the twelfth day, when it became normal. The pulse ran from 104 to 130, then settled to 120 before discharge, February 1. Leucocytes at 10.35 P.M., eight hours after beginning operation, were 8500. There was primary union of wound, and patient felt at once relieved of a feeling of tension in the eyes. The exophthalmos remained, but the eyes assumed a less staring and more natural appearance.

May 11, 1903. Neck measures fifteen and three-quarters inches. Pulse, 100. Barely perceptible tremor in hands. Exophthalmos much less, especially right. Can shut right eye completely, left almost. Convergence normal. Lids follow globes well. Feels very well, eating and sleeping excellently. No complaints and gaining constantly. Thinks left side of goitre has shrunk more than right.

CASE XVIII.—Julia C., twenty-five years; single; English; stenographer. Admitted St. Luke's Hospital, February 3, 1903. Referred by Dr. Joseph Collins. Family history negative.

Personal History.—Measles, whooping-cough, and scarlet fever in childhood. Typhoid fever last summer. Menstruation began at fifteen years. Takes wine in moderation. Has worked hard and for long hours.

Present History.—Two years ago noticed swelling in neck, gradually increasing. Always nervous, but worse of late years, especially since typhoid fever. Now very hysterical and tremulous. Exophthalmos since the typhoid, but improved lately under medical treatment. For a year has had rapid heart action on exertion. Feels "burning up" and has itching of skin, especially at night. Severe headaches. Flatulence. Bowels regular. Appetite poor.

Examination.—Medium height, slight frame. Slight exophthalmos. Pupils dilated and equal, react sluggishly to light and accommodation. Stellwag, von Graefe, and Moebius signs not present. Tongue moist and tremulous. Marked tremor of hands and general restlessness. Face flushes readily. Thyroid gland slightly enlarged. Marked throbbing of neck vessels.

Heart apex beat in fifth intercostal space, four and one-half inches from mid-line, very diffuse and forcible. Action rapid.

Systolic murmur at apex, transmitted into axilla and heard with more intensity over pulmonary valves. Pulmonic second sound much accentuated. Marked systolic murmur over thyroid gland. Pulse rapid (120), small, fair force, without unnatural tension.

February 3 to 6. Urine acid, 1018, trace of albumen, no sugar. Few hyaline and granular casts. Aconite, bromide, and ice-bag to heart were begun, but discontinued because stomach was upset. Nausea and vomiting would not allow medication or much feeding. Was prepared for operation for the 6th, 2 P.M., but had sudden fever just before going to operating room, and operation was postponed. 6 P.M., leucocytes were 9000.

February 13. Patient having improved, operation undertaken at 2 P.M. Pulse, 108; respiration, 32. Ether narcosis, preceded by nitrous oxide. Both incisions made at once. Left nerve and all three ganglia first removed. The nerves were separated into several fine fibres, not a single cord, and it was difficult at first to find them. When the nerve was clamped above, each pupil contracted first, then dilated as the nerve was avulsed. Usual technique and no drainage. Patient bore anæsthetic badly. Heart's action at first tumultuous, then quieter, but rapid, and much mucus collected in the air passages. She was allowed to come to and cry out during suture of the wounds, and her color improved very much. At end of operation, pulse, 130; respiration, 24. Operation lasted ninety-five minutes. Recovered without nausea, but was very restless, and sodium bromide was given by rectum (6 P.M.).

8 P.M. Pulse 204, fair force. Restless.

9 P.M. Strychnine sulphate, gr. $^1/_{30}$.

9.30 P.M. Saline enema and whiskey half an ounce. Ice-bag to heart.

11 P.M. Strychnine sulphate, gr. $^1/_{30}$, every two hours. Foot of bed elevated. Alcohol sponge-bath for ten minutes.

11.50 P.M. Ice-bag to nape of neck.

12.05 A.M. Magendie, minims v, hypodermically.

February 14, 12.30 A.M. Nutrient enema and sodium bromide.

6 A.M. Restless. Irrational. Stop ice-bag to nape of neck. Make strychnine every four hours.

February 14, 9 A.M. Kemp's tube and irrigation of rectum for one hour. Magendie, minims v, hypodermically.

Urine acid, 1030, trace of albumen, granular casts.

11.45 A.M. Very restless. Saline intravenous infusion 1000 cubic centimetres, with slight improvement.

12.40 P.M. Kemp's tube, irrigation one hour.

1 P.M. Magendie, minims v.

3.45 P.M. Saline intravenous infusion 1500 cubic centimetres.

5 P.M. Pulse stronger. Twitching of limbs.

7 P.M. Quieter. Pulse poor.

9.50 P.M. Extremities cold.

9.55 P.M. Died.

THE SURGICAL TREATMENT OF EXOPHTHALMIC GOITRE.[1]

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It is now nearly a century since exophthalmic goitre was first described by Caleb Parry and seventy years since Graves wrote his classical essay upon the subject, and yet the treatment of the disease has never been satisfactory, in most instances merely alleviating the symptoms. The clinical picture of exophthalmic goitre is so typical that the diagnosis is always easily made unless exophthalmos is absent, when careful inquiry of the early symptoms and course should correct any doubt as to the true condition.

Miss A. B., aged twenty-four years, referred to me by Dr. Charles K. Ladd, of Towanda, Pa., was admitted to the German Hospital on December 30, 1902. The family history is quite interesting; her father is living and well, but is frequently nervous and irritable; her grandmother and mother died from heart trouble, and were also of nervous temperaments. A brother died from heart disease, chorea, and rheumatism. She had measles, whooping-cough, and varicella when a child; menstruated first at fourteen, continuing regular and without dysmenorrhœa until last summer, when she missed several periods. There is a history of frequent convulsions up to the age of eight, but their nature could not be determined. At the time of beginning menstruation there was distinct enlargement of the thyroid gland, lasting about one year and disappearing under the use of electricity. There was no palpitation nor dyspnœa at this time, but she had a number of fainting spells. She suffered from slight rheumatic attacks during girlhood.

Four years ago the thyroid gland became enlarged and the eyeballs prominent, with attacks of indigestion, abdominal colic,

[1] Read before the Philadelphia Academy of Surgery, March 2, 1903.

and nervousness. The goitre continued with a gradual increase in the symptoms of indigestion until March, 1902, when the entire symptom complex of exophthalmic goitre manifested itself. Her neck increased in size, with resulting dyspnœa and inability to wear a collar or anything tight around the neck; she became nervous, irritable, and easily upset; worried over trifles, always anxious to finish anything undertaken, and restless until the task was finished. Palpitation of the heart was present and increased by exertion. She became breathless and weak after climbing stairs, and suffered from frequent spells of profuse perspiration over the entire body, most marked over the chest, neck, and arms.

Her appetite became capricious, and for two months she suffered from diarrhœa. There has never been any jaundice present. These symptoms have been continuous until admission, when the following observations were made:

The eyes are prominent, easily irritated with frequent lachrymation, widely dilated pupils, and an injected conjunctiva; winking is infrequent. The palpebral angle is widened, but the sclera is not visible below the upper lid, and the lid readily follows the movements of the eye. No lagophthalmos can be observed, nor is there corrugation or wrinkling of the eyebrows when the patient looks up. There is slight internal convergence.

The thyroid is symmetrically enlarged, without a thrill, and by auscultation a venous hum can be heard over the struma and the carotid vessels. Slight hoarseness is present, the patient's voice becoming husky after talking to any extent. Tachycardia is present with arrhythmia.

The pulse averages 120 when quiet, but increases with the slightest exertion up to 160. The apex beat is in the fifth interspace, diffuse, and seen beyond the nipple; the impulse is moderately forcible, and a slight initial systolic murmur can be heard, transmitted to the axilla.

The lungs and abdomen were negative. A tremor of the fingers can be seen upon extension of the hand, especially noticeable when the patient becomes excited.

There was no polyuria, the urine containing a trace of albumen, but no sugar or casts. The blood count showed no anæmia, with 10,320 leucocytes and an eosinophile of 10.5 per cent. The temperature was always normal before operation, the respirations ranging from 20 to 24.

One week after admission, bilateral resection of the cervical sympathetics was performed under ether anæsthesia. An incision five inches long was made along the posterior border of the right sternomastoid muscle, which was reflected forward along with the great vessels and pneumogastric nerve. The sympathetic nerve and its three ganglia were found and removed entire from a point one-half inch above the superior ganglion to one-half inch below the inferior ganglion. The middle ganglion was located as lying upon the inferior thyroid artery, the inferior ganglion being behind the subclavian artery. After checking all hæmorrhage, the wound was closed with a continuous silk suture and a collodion dressing applied.

The operation was repeated on the left side, the middle ganglion being found just above the inferior thyroid artery and the inferior ganglion just below the same blood-vessel. On account of the high position of the lower ganglion, the nerve was cut well below it, in order to remove the entire origin of the inferior cardiac nerve. Silk sutures and a collodion dressing closed this wound also.

Patient took ether badly from the start; was cyanosed and full of mucus; had some trouble with nasopharynx previous to operation. Operation was interrupted several times on account of the anæsthetic. At completion of operation the patient's color was very bad and pulse rapid and irregular; was given oxygen for an hour after operation. On coming out of the anæsthetic she vomited clear mucus in gushes. Commenced cough almost at once, and cough continued, accompanied by intermittent expectoration of large quantities of seromucus. Several hours after operation both lungs were noted to be full of moist bubbling râles, and respiration was labored and harsh. Patient remained cyanotic, and received oxygen at fifteen-minute intervals for several days. The day following operation she was bled from left arm and lungs cupped posteriorly. Both bases flat. Patient remained cyanotic and with rapid pulse for several days. Symptoms gradually subsided, and patient made satisfactory recovery.

The immediate benefit of the operation to the tachycardia could not, unfortunately, be observed, as the patient developed a severe pneumonia twelve hours after the operation, and for several days she was in a perilous condition, the temperature reaching 105° F. and slowly declining, reaching the normal seven days after operation.

The exophthalmos was noticed to have disappeared almost entirely twenty-four hours after the operation, and, after her recovery from the lung condition, convalescence was rapid. The wound healed by first intention, and on January 31, twenty-six days after operation, the patient was discharged, with no appreciable exophthalmos and with entire disappearance of all nervous symptoms. The goitre, though diminishing, was still present, but causing no discomfort. On February 26 the patient writes that she is quite well and markedly improved by the operation.

The underlying causes of exophthalmic goitre are obscure and subject to much debate; whether a direct or reflex stimulation of the sympathetic, a neurosis, a lesion, a compression, or an intoxication has not definitely been determined. The progress in the study of the internal secretion of this gland, like all the other ductless glands, has been slow, and has not furnished a satisfactory cause beyond the probable alteration of the secretion.

At the present time three theories are advanced, viz., hyperthyroidization, disease of the central nervous system, or alteration in the sympathetic system.

The arguments in favor of a lesion of the thyroid gland itself are mainly based on the failure to find reliable postmortem evidence of disease of the nervous system, and the altered secretion of the thyroid is supposed to exert a direct or indirect toxic action upon the heart, nervous system, and general nutrition, the exophthalmos being caused by a local deposit of fat behind the eyeball. Mikulicz and Reinbach believe that while the presence of Basedow's disease cannot be explained by an excessive function of the thyroid, yet the hypertrophy of this gland plays a prominent rôle by adding the phenomena of thyroidism to the other symptoms. The failure of thyroidectomy is therefore to be ascribed to the fact that, in spite of the removal of this factor, the primary injury, viz., the nerve lesion, is sufficiently severe to render the phenomena of the disease continuous. The influences of heredity, age, sex, and temperament tend with remarkable unanimity to point to a nervous origin.

The tachycardia, hyperidrosis, tremor, decrease of electrical resistance, and general nervous unrest which are so constantly present would also denote a nerve influence. There are some cases, also, in which the enlargement of the thyroid is very slight or even absent.

For the present, at least, we must assume that exophthalmic goitre is dependent upon all these factors, and that a lesion of one may cause specific alterations in the others, with the production of the well-marked symptoms denoting the disease.

The diagnosis from simple parenchymatous goitre must be made in those cases where the exophthalmos is absent, particularly when the ordinary form of goitre is accompanied by cardiovascular symptoms. The most marked points in which the simple goitre differs are the irregularity of the position of the enlarged thyroid, the direct pressure upon the trachea from the size of the growth with dyspnœa and stridor, and the more mild character of the nervous and vascular phenomena if present together, of course with the absence of the exophthalmos.

The treatment of Graves's disease with drugs is unsatisfactory, and all like diseases, the medical cure of which has been unsuccessful, the number of so-called curative remedies is a large one. Digitalis, belladonna, bromine preparations, iron, and various nerve sedatives have been most frequently used.

Electricity, galvanic and faradic, has been tried without any benefit; iodine and thyroid feeding aggravate the symptoms.

There are four surgical procedures adopted:

1. Partial thyroidectomy.
2. Ligature of the thyroid vessels.
3. Operations upon the cervical sympathetic nerves.
4. Operations upon distant parts of the body.

In addition to these operations, exothyropexy has sometimes been employed, performed by exposing the gland and drawing it out of the wound and leaving it exposed to the

air. Atrophy is supposed to result, but the operation is dangerous, ineffectual, and very disfiguring.

Thyroidectomy has been the operation usually performed for the relief of exophthalmic goitre, especially when the cause is believed to be hypersecretion of the thyroid epithelium. It must be admitted that this operation has furnished good results, especially in the hands of Kocher, but the mortality has been very high. Starr, Sorgo, and Iricomi have published statistics up to 1896 with a mortality varying between 12 and 15 per cent. and a cure obtained from 25 to 39 per cent. Partial resection has been the method used, because, unlike the simple goitre, that in Graves's disease cannot be enucleated. Ætherization of these patients is difficult and fraught with danger, especially from a postoperative pneumonia, and Kocher, recognizing this fact, always uses local anæsthesia. The escape of the thyroid secretion over the cut surfaces during the removal has been believed to aid in the production of a postoperative thyroid intoxication.

Ligature of the thyroid vessels has been tried, especially by Kocher, in the hope that by cutting off the blood supply the gland will undergo atrophy. The exposure of the inferior thyroid vessels may be a difficult task. Kocher usually ties off both superior and one inferior thyroid artery, and frequently combined this operation with partial resection of the gland or resection of the cervical sympathetics in severe cases; the combined operations are often performed in several sittings.

Section of the cervical sympathetic for exophthalmic goitre was first performed by Jaboulay, of Lyons, in 1896, and later in the same year, Jonnesco, of Bucharest, resected part of the nerve together with the superior cervical ganglion. The results were not sufficient, however, and Jonnesco and others extended the operation until complete bilateral excision of the entire cervical sympathetic nerve with its three ganglia, and even in some cases the upper thoracic ganglion, was advocated.

The theory upon which the operation is based presupposes

the nervous origin of the disease with alteration of the sympathetic nerve. Each of the three cardinal and also the subsidiary symptoms are believed to be dependent upon stimulation of this nerve. Exophthalmos is caused by a stimulation of the cervical sympathetic leading to an energetic contraction of Müller's smooth muscle at the posterior pole of the bulb, the dilatation of the pupil is due to the same irritation of the cervical sympathetic which communicates with the lenticular ganglion and its ciliary branches to the iris.

The goitre depends either upon an enormous dilatation of the vessels of the thyroid from stimulation of the vasodilator fibres of the neck, or, as Jonnesco believes, it is due to an increased activity of the thyroid epithelium with hypersecretions which are dependent upon the permanent stimulation of the secretory nerve-fibres of the thyroid. Resection of the sympathetic, and consequently of the vasodilator, vasoconstrictor, and secretory nerve-fibres, results in atrophy of the thyroid.

Tachycardia is likewise to be attributed to the irritation of the sympathetic which communicates with the cardiac plexuses by several branches, the accelerator nerves of the heart muscle.

The nervous and digestive phenomena are dependent upon changes in the cerebral circulation, possibly a permanent cerebral anæmia produced by a continuous stimulation of the vasoconstrictor fibres of the cervical sympathetic. The vertebral nerve containing a number of vasomotor filaments is given off from the inferior ganglion. Removal of these fibres produces cerebral congestion.

The various operations on the cervical sympathetic for the relief of exophthalmic goitre are the following: (1) Simple division of the cervical sympathetic; (2) ablation of the cervical sympathetic by means of Jaboulay's operation, which, without a large incision, is devised to stretch and twist the nerve by means of forceps attached to its upper and lower ends; (3) simple stretching the cervical sympathetic; (4) partial resection of the latter; (5) partial and extensive resection; and (6) total resection.

Belacescue believes that extensive *partial* resection is only indicated in the cases of Basedow's disease in which the tachycardia is not intense. He believes that the entire bilateral resection with removal of the uppermost thoracic ganglion is easy of performance and harmless in its results, with a far greater percentage of cures than any other operation for the relief of exophthalmic goitre, and practically no mortality.

His statistics show 59 per cent. of cures, 29 per cent. of improvements, and 12 per cent. of failures, with no deaths directly due to the operation.

Jonnesco is also very enthusiastic, having performed over 130 bilateral sympathectomies in the last five years, in two cases removing the first thoracic ganglion. He has not observed in any of these cases any trophic or circulatory disturbances. Of this series, fifteen were performed upon patients suffering with exophthalmic goitre, with a complete cure or marked improvement. The three cardinal symptoms of the disease disappeared completely, nutrition became normal, and the nervous condition was restored to its original stability.

The operation should not be undertaken unless the surgeon is perfectly familiar with the anatomy of the area of operation and able to cope with any anomaly in the course of the nerve or the position of its ganglia. The difficulties encountered during anæsthesia are similar to those in all operations upon the thyroid, and require the careful attention of the anæsthetist at all times.

In severe cases with marked exophthalmos and pronounced nervous irritation, the operation may be performed in two sittings about a fortnight apart, removing one side at each sitting. This undoubtedly insures a more successful result.

In addition to exophthalmic goitre, cervical sympathectomy has furnished excellent results in chronic glaucoma. Jonnesco was the originator, and has collected thirty-five cases, twelve his own, with marked improvement in all but about six cases.

Suker has collected twelve cases, operated upon in this country, with removal of the superior cervical ganglion, with good results, and believes the operation should be performed

in absolute and hæmorrhagic glaucoma; in chronic glaucoma, especially when an iridectomy or sclerotomy has failed, and at all times when other operative measures are refused, irrespective of the form of glaucoma.

The removal of the ganglion causes: (1) Contraction of the iris, (2) relaxation of the circumbulbar muscle, (3) vascular dilatation, (4) lower intraocular tension, and (5) a decrease in the elements constituting the aqueous.

Only the side affected should be operated upon. Jonnesco has also obtained brilliant results in epilepsy by resection of the sympathetics, on the hypothesis that epileptic attacks are due to cerebral anæmia from irritation of the cervical sympathetics with narrowing of the lumen of the cerebral blood-vessels. "Section of the cervical sympathetics by cutting off the avenue through which such impulses are carried prevents the occurrence of brain anæmia, and so permits the uniform and constant nutrition of brain tissues on which cerebral stability depends. The section of the cervical sympathetic also seems to act favorably by preventing the flood of nervous impulse or reflexes from irritated abdominal or pelvic organs to the brain." (Jonnesco.)

Jonnesco has operated on over 100 epileptics, and records the results for 1896, '97, and '98.

During these years forty-nine were operated upon, with twelve cures and four improvements. These results are accurate, because they have been frequently observed after operation, and he does not regard any of his results as definitive until at least two years have passed.

In migraine, facial neuralgia, and maniacal irritation the operation has failed to produce results, though but few cases have been subjected to operation.

From my own simple observation, and from a study of the works of those whose experience with the operation has been extensive, I can make the following conclusions:

1. That as surgical treatment is recognized as the most satisfactory in exophthalmic goitre, so is complete bilateral cervical sympathectomy to be considered the operation of choice.

2. The operation should not be performed during the height of psychical irritation or tachycardia, nor by an operator who has not an absolute knowledge of the anatomy of the neck and a large experience in dealing with difficult operative procedures, or the means at hand to cope with any emergency.

3. The results of the operation are far better than the other procedures, the mortality is much lower, and in cured cases the improvement is permanent.

4. In chronic glaucoma, especially after the failure of iridectomy and sclerotomy, this operation may restore vision completely, unless the disease is too far advanced with absence of light perception.

5. In recurring attacks of epilepsy, sympathectomy should be resorted to. The results warrant the operation.

BILATERAL BONY ANKYLOSIS OF THE TEMPOROMAXILLARY ARTICULATION OF TRAUMATIC ORIGIN AND ITS SURGICAL TREATMENT.[1]

WITH REPORT AND PRESENTATION OF TWO CASES RECENTLY TREATED BY OPERATION.

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BONY ankylosis of the temporomaxillary articulation of traumatic origin, not complicated by the results of infection, is probably comparatively rare, and I am strongly of the opinion that it invariably results from some variety of fracture involving the bones comprising the joint. It could therefore quite properly be considered among the sequelæ of fractures of these bones. The title of this paper, therefore, not only excludes many other etiological factors producing fixation of the mandible, but all the other forms of ankylosis of whatever degree.

In this report I hope to establish the true etiology in each of the two cases presented; to point out a symptom very apt to mislead in reference to the true condition; to demonstrate a most valuable method for determining the true condition of the articulations, a method which shows whether both articular surfaces are involved and also the degree of involvement of each; the report also deals with the practicability of the treatment employed, the dangers to be anticipated, and the methods of meeting them.

CASE I.—F. H. H., aged eighteen years, when eight years of age met with an accident while coasting. The sled which he and

[1] Read before the Philadelphia Academy of Surgery, February, 1903.

FIG. 1.—Case I. Showing the recession of the chin and the fulness in the region of the temporomaxillary articulation.

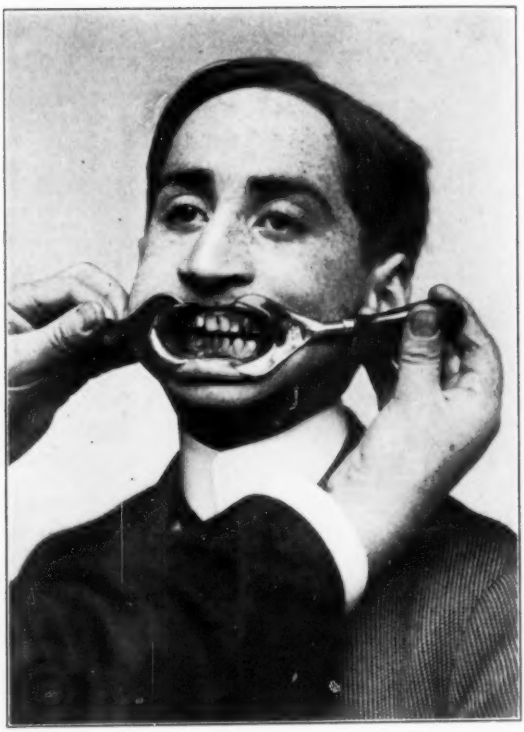

FIG. 2.—Case I. Showing the posterior teeth in occlusion and the anterior teeth separated some distance.

two others were upon ran into a barbed wire fence, and he was thrown violently against a post, striking his chin. He was unconscious for a short time, but regained consciousness while being conveyed home. He again became unconscious, and remained so until the following morning, a period of about twelve hours. He had a wound about one and one-half inches long beneath the chin, exposing the bone, and there were evidently multiple fractures of the mandible. The wound was dressed, and the mandible was bandaged for five weeks, at the end of which time the bandages were discontinued, when, in attempting to open the mouth, it was found that ankylosis had taken place.

About five years after the accident, he said, he came under the care of Dr. Fowler, at the Seney Methodist Hospital, Brooklyn, who gave him ether and forcibly opened his mouth by means of levers. This treatment was followed by the use of a screw-gag three or four times daily during a period of about three months, at the end of which time fixation was again practically complete. Two years later, Dr. Glass, of Utica, repeated the same operation and after-treatment, and subsequently on two occasions, at intervals of two years and one year, with like results. An additional attempt was made under ether in the office of a dentist.

The patient was kindly referred to me in October, 1901, by Drs. Roy E. Jones and Joshua T. Pritchard, of Remsen, New York. Photographs taken at that time show the appearance which he presented (Figs. 1 and 2). The noticeable features were marked recession of the chin and considerable fulness in the region of each temporomaxillary articulation. The facial measurements were as follows: from the hair-line to the glabella two and three-fourths inches, from the glabella to the line of the union between the nose and upper lip two and three-fourths inches, from the latter line to the point of the chin two and three-fourths inches, and from the point of the chin to the line of harmony one and one-fourth inches. The mandible was firmly ankylosed with the posterior teeth in occlusion, and the anterior teeth separated some distance, as seen in the photograph (Figs. 1 and 2). He was able voluntarily to separate the teeth in occlusion about one-tenth of a centimetre. Upon examination of the muscles of mastication, I found them fairly well developed, evidently free from adhesions, and able to contract strongly, he having daily exercised their limited power. The size of the man-

dible led me to believe that development had practically ceased at the time of injury, as it apparently was not larger than that of a boy of eight years of age. The rami formed almost right angles with the body, and they were decidedly more vertical than normal. There was no apparent deviation of the chin to either side. There was no difference manifested in motion between either half of the mandible.

Being still in doubt in regard to the exact position of the condyles, I was fortunate in securing very excellent skiagraphs, which were taken by Dr. Charles Lester Leonard (Fig. 3). Each skiagraph shows the greatly enlarged condyle or mass of bone connecting the ramus with the temporal bone, about one-half of which is behind the posterior border of the ramus. This led me to believe that part of the original injury was a fracture through the neck of each condyle and union between the condyle and ramus at almost a right angle.

I decided to operate first upon the right side, and about one week later upon the left side, by the following method, which I will give in detail.

On December 2, 1901, while the patient was under ether anæsthesia, I made an incision opposite the neck of the condyle of the right side, beginning just below the zygoma and extending downward for a distance of one and one-fourth inches. The anterior border of the parotid gland was next retracted backward, exposing the masseter muscle. With a blunt-pointed dissector the fascia and fibres of the masseter muscle and periosteum were separated about opposite the middle of the skin incision; after dilating this opening with forceps two index-fingers could be introduced. Through this opening there was made a subperiosteal excision, with a chisel, of the mass of callus, including the condyle and neck, and a bridge of bone which was found present. It connected the outer surface of the head and neck of the condyloid process with the outer surface and lower border of the posterior portion of zygoma, and was about one-third of an inch in thickness and three-quarters of an inch in width. There was no union between the articular surfaces, and there was an apparent absence of the interarticular fibrocartilage. After clearing the border of the zygoma and making smooth the excised border of the ramus, it became possible to pass the index-finger freely between the ramus and glenoid fossa, and to spring the mandible

FIG. 3.—Case I. Skiagraph showing the bridge of bone connecting the right temporomaxillary articulation, the angle formed by the occiput and mandible with the cervical vertebræ, and the position of the hyoid bone.

sufficiently to demonstrate that, except for its muscular attachments, it was free upon that side. After carefully flushing with water to remove any chips of bone, the separated fibres of the masseter muscle and fascia were brought together with buried catgut sutures. The skin wound was closed with Halsted's subcuticular suture, using silkworm gut. This is in accordance with the view of Gregg, who recommends closing the wound without drainage. (*Practitioner,* December, 1899.)

The same procedure was repeated on December 9 upon the left side, and almost precisely the same condition of the articulation was found. As soon as the section through the neck of the condyle was complete, the mandible dropped a little distance. When the excision was completed, and before the wound was closed, an ordinary mouth gag was placed between the teeth and opened until the mouth seemed about the normal size. Then by grasping the mandible some lateral manipulations were made, after which the wound was closed.

There was no special interference with respiration during either operation, and the patient made a rapid and uninterrupted recovery from each. The wounds healed by primary union, and in each case the sutures were removed on the eighth day. He was allowed to open his mouth as freely as the bandages would permit, and ten days after the second operation, when he left for his home, he could voluntarily separate the anterior teeth to the extent of one inch, and was learning to masticate solid food. Three weeks later he could open his mouth one and one-eighth inches. There was paralysis of the muscles supplied by the malar and infraorbital branches of the temporofacial division of the seventh nerve, from which condition he gradually but completely recovered in two months. He has actively exercised the muscles connected with the mandible, and at the present time can open his mouth one and one-quarter inches, and has considerable lateral movement.

Case II.—E. W., aged eighteen years, when five years of age fell from a roof to the brick pavement, a distance of about fourteen feet, striking his mouth and chin. He bled profusely from the mouth and nose, and two of the upper front teeth were knocked out. Dr. Winter was called, and upon examining him found nothing wrong except injury to the teeth and gums, and, after controlling the hæmorrhage, ordered the application of ice-

bags to the sides of the face. Considerable swelling took place in the region of the mandible, and the tumefaction was especially marked upon each side at the sites of the articulations. He was referred by Dr. Winter to Dr. Brown, a dentist, who removed two other teeth that were loose, and then fastened several lower teeth in place by wiring them. The patient was never able to open his mouth as wide after the fall as before, and a gradual decrease in the movements of the mandible was noticed, until at the end of nine months only very slight motion was possible. He applied for treatment at several hospitals in Philadelphia, and at one institution he received treatment three times each week for a period of five months. The following plan was pursued: His teeth were separated as far as possible by means of a screw-gag, and then a wedge of soft wood was placed between them, after which the gag was removed, leaving the wedge of wood between the teeth for three days, provided he was able to bear the pain. It being necessary to use the gag in order to remove the wedge of wood, the patient almost invariably returned in twenty-four hours, but occasionally endured the suffering for two days. When the wedge was removed, the mandible could not be moved voluntarily, but would gradually close the space acquired between the teeth, and in doing so would give pain at the site of the articulations. The treatment was abandoned by the patient at the end of five months, owing to the suffering caused and the absence of any improvement in his disability.

He was referred to me by his family physician, Dr. Heller, about fifteen months previous to the time at which I operated. Photographs taken at that time show the appearance which he presented (Figs. 4 and 5). The noticeable features were marked recession of the chin and absence of any fulness in the region of each articulation. The relative displacement of the point of the chin was three-eighths of an inch below and one and three-eighths inches behind its proper position, according to the line of harmony, the divisions of which measured as follows: from the hair-line to glabella two and one-fourth inches, from the glabella to the line of union between the nose and upper lip two and one-fourth inches, from the latter line to the point of the chin two and five-eighths inches, and from the point of the chin to the line of harmony one and three-eighths inches. The mandible was ankylosed with the posterior teeth in occlusion, and the

FIG. 4.—Case II. Showing the recession of the chin.

FIG. 5.—Case II. Showing the posterior teeth in occlusion and the anterior teeth separated some distance.

anterior teeth separated the distance shown in the photograph (Fig. 5). He was able voluntarily to separate the teeth in occlusion about three-tenths of a centimetre. The muscles of mastication were fairly well developed, evidently free from adhesions, and able to contract strongly, he having exercised their limited power daily. The development of the mandible had evidently ceased at the time of the injury, as the bone was apparently not larger than that of a boy five years of age. The rami were almost at right angles to the body and were decidedly more vertical than normal. There was no apparent deviation of the chin to either side, and no difference during passive or induced motion in either half of the mandible. I was again fortunate in securing skiagraphs (Fig. 6) taken by Dr. Charles Lester Leonard. Each skiagraph shows practically the same condition as did those of the other case, and I therefore concluded that the original injuries and the results were similar. Having decided to employ the method used in the previous case, I operated February 13, 1902, upon the right side, and found the assumed condition existing, except that the dimensions of the bridge of bone were somewhat less. The details of the operation were precisely as those previously described. The operation was uneventful, and the only point of interest, especially in connection with future developments, was the occurrence three times of embarrassed respiration, followed by slight cyanosis, which disappeared upon the temporary discontinuance of the ether; this, however, did not cause any alarm or apprehension, as I have frequently seen the same condition more marked under ordinary circumstances. His convalescence was rapid and uninterrupted, and on February 20 I operated upon the left side, employing the same method, and found practically the same condition. In this, as in the first operation, the ether was administered by Dr. W. R. Roe; some slight difficulty was experienced, as noted in the first operation, and special care was therefore exercised to administer the minimum quantity under which the operation could be performed, and he was barely under the influence of ether at any time. When the section through the neck of the condyle was completed and the mandible dropped slightly, more decidedly embarrassed respiration occurred, and continued to some extent while the work of removing the condyle and making smooth the zygoma and upper portion of the ramus was being completed. When the mouth gag

was placed between his teeth and the jaws separated, respiration ceased; in order to restore it, rhythmical tractions were made upon the tongue, while an assistant made artificial respiration by Sylvester's method. In addition, the patient was placed in the Trendelenburg position and given hypodermically one-tenth grain of strychnia sulphate. Different positions of the head were also tried. These means failing, an attempt was also made to reach the epiglottis with the index-finger; but this failed, there not being sufficient separation between the teeth. Having spent probably more than a minute in these unsuccessful attempts, and the patient being in a state of complete relaxation, with extreme cyanosis, a rapid laryngotomy was performed by plunging a scalpel through the cricothyroid membrane, cutting down to the cricoid cartilage in a vertical direction. Finding this space insufficient, the incision was extended upward between the two lateral halves of the thyroid cartilage. This gave ample room to open the larynx widely, and, as the artificial respiration was continued, the cyanosis lessened and soon natural respiration was re-established. Fearing that infection of the wound upon the left side might have occurred during the attempts at restoration of the patient, and also because some hæmorrhage was taking place, the wound was packed with gauze, and then closed as in the other operations, except at the lower portion which the gauze occupied. As soon as the dressings were applied and the mandible was held in its original position with the bandages, he began to breathe partially through the mouth and nose. A tracheotomy tube was kept ready to introduce at once if such a step should become necessary to keep the laryngotomy wound open. The laryngotomy wound was closed one hour after it was made, as he was breathing naturally, and there seemed no further use for the artificial opening. In closing it, three sutures were placed in the skin, allowing the lateral cartilages and cricothyroid membrane to approximate, as they readily did. A gauze drain was placed between the cartilages and the skin, and was brought out at the lower angle of the wound. He made an uninterrupted recovery, not a single dose of medicine was given, and the only thing he complained of was some swelling of the tongue (the result of the application of the forceps), and insomnia. The gauze drain in the laryngotomy wound was removed in two days, the sutures in five days, and on the eighth day the wound was

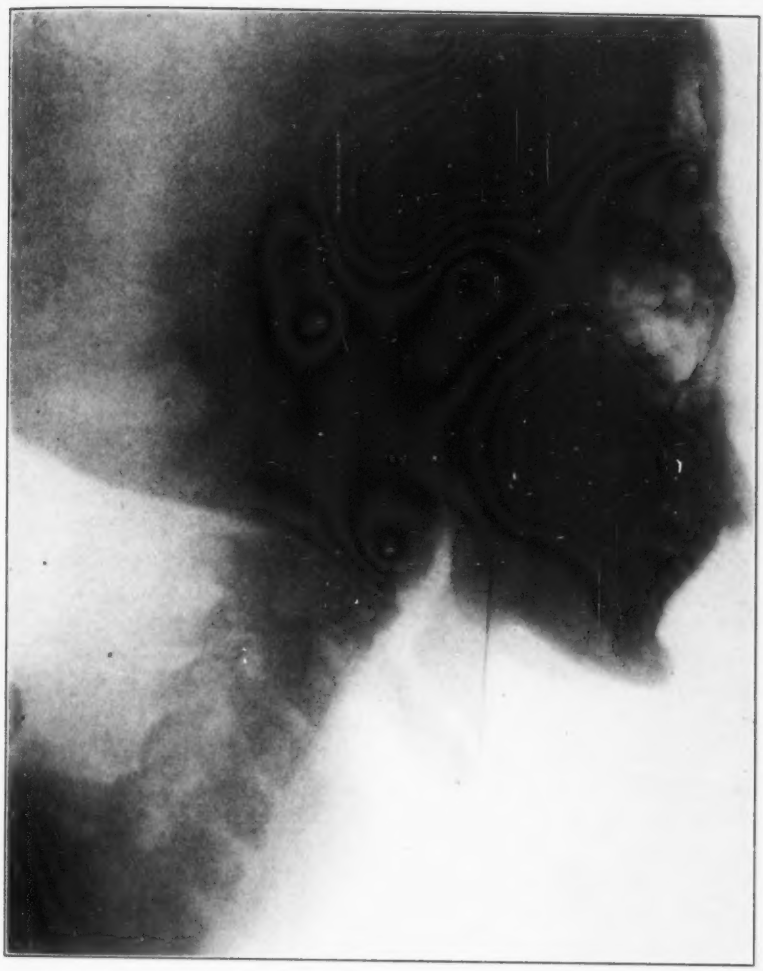

FIG. 6.—Case II. Skiagraph showing the bridge of bone connecting the right temporomaxillary articulation, the angle formed by the occiput and mandible with the cervical vertebræ, and the position of the hyoid bone as compared with Fig. 3, Case I.

entirely healed. The packing was removed from the left articulation on the third day, the sutures on the eighth day, and the wound was entirely healed on the twelfth day, no infection having taken place.

In the first case, while the patient was under ether, the mouth was opened widely by stretching the muscles and fascia connecting the mandible, and it was made readily movable. In the second case a similar procedure had been begun, but the mouth was opened only about half-way when respiration failure occurred. It is unfortunate that this procedure was not completed while the patient was breathing through the laryngotomy wound, as it could then have been done with safety. Fearing a repetition of interference to respiration if he were given an anæsthetic to complete the opening of the mouth, the use of the mouth gag was begun twelve days after the operation. This plan is to be noted, for each method had its advantages and disadvantages. In the first case, the overstretching of the muscles so long contracted would necessarily result in strain and laceration of some of their fibres, and thus cause weakening of the muscles. The cicatricial contraction of healing would also lessen their ultimate functional power. In the second case, although believing that the slight stretching of the muscles was free of the dangers incident to the overstretching of the same, and promised better development, it seems possible that the resistance of the fascia would not be sufficiently overcome to secure an extensive range of motion to the mandible. The mouth gag was used at intervals of two and three days, and then only with very moderate force, owing to the fact that slight pressure upon the teeth caused considerable pain, as the tissues of the alveoli had never been accustomed to resisting pressure by mastication.

Considering both cases carefully, it appears that the results are just as good after the second plan as after the first. Paralysis of the same group of muscles as occurred in the first case was present in the second, but it had entirely disappeared at the end of two months. The laryngotomy was followed by some functional disturbances, for instance, slight hoarseness and inability to speak loud, from both of which conditions he entirely recovered. His present condition is very satisfactory. He can open his mouth one and one-quarter inches, but has practically no lateral motion.

With a view of ascertaining the strength of the muscles of mastication in these two patients, I used an instrument, the gnathodynamometer, invented by Dr. G. V. Black, Dean of the Northwestern University Dental School of Chicago. As to the average strength of the human bite, trials taken two years ago by Dr. Black in his senior class gave pressures with the molar teeth all the way from forty to 275 pounds, or the total number of pounds registered by the instrument. The average of these trials was $171^{6}/_{10}$ pounds. Trials taken a year later in his senior class averaged 132 pounds on the molars and but fifty-two pounds on the incisors, and varied all the way from thirty to 275 pounds on the molars. These trials included about 125 persons each, and were taken without any selection of persons whatever, and usually a person made but a single effort.

The results seem to depend almost entirely upon the condition of the peridental membranes. The large majority stop because of pain in the peridental membranes, not because they have used their full muscular strength; consequently, the results, taken as a whole, do not give the muscular strength of the jaws, but are simply an index to the condition of the peridental membranes.

I was disappointed by not being able to use this instrument satisfactorily in either of these cases for the following reasons: The first molars were badly decayed and were extracted subsequent to the operation, and, owing to the lack of development of the mandible, the position of the second molars was so far posterior and the distance between the blades of the instrument being thirteen-sixteenths of an inch, there was not sufficient space between the occlusive surfaces of these teeth to introduce the instrument sufficiently to prevent its slipping.

In the first case, with the instruments between the anterior teeth, it registered fifty pounds and in the second case forty pounds. It was quite evident that neither patient exerted his full muscular power, but stopped owing to pain in the peridental membranes.

The first thing which this report seeks to establish is the true etiology in each of the cases. It seems evident that ankylosis resulted from fractures through the neck of the condyloid processes, for the following reasons:

Fracture of the neck of the condyle is not as infrequent as is generally supposed. In forty-one cases of fracture of the mandible which Dr. W. R. Roe and myself have treated, the line of fracture in six cases (two of which had multiple fractures) was through the neck of one condyle, and in one case the lines were through the necks of both condyles. The displacement at the site of the fracture in each of these cases was forward and upward, the fragments being brought closer to or in contact with the lower border of the posterior portion of the zygoma. If the sharp ends of the fragments are in contact with the zygoma, they may have denuded this process of its periosteum at the time of the injury; or if the fragments are not in contact with the zygoma, but are nearer the same than if they were retained in their proper relation to each other, and not completely immobilized, the irregular masses of callus which form in the process of repair frequently reach the lower border of the zygoma, and mechanically denude the same of its periosteum. This will explain the gradual and frequently slow occurrence of bony ankylosis in a number of reported cases. The skiagraphs in each case show clearly the angular displacement upward and forward of the neck of the condyle. This displacement, in connection with the more vertical position of the posterior border of the rami, together with the separation of the anterior teeth and the occlusion of the posterior teeth, tallies accurately with the conditions which theoretically should result from such fractures. The delineation of the skiagraphs was verified at the time of operation, and the bridge of bone was found to exist.

A very misleading symptom in reference to the true condition was the ability to move the mandible one-tenth of a centimetre in the first case, and three-tenths in the second case. This might seem to prove that true bony ankylosis was absent, because we assume that in true bony ankylosis there can be no motion. Cabot first called attention to this, and said it was due to the springing of the bone. In both of my cases it certainly was due to this cause. The skiagraphs demonstrate a most valuable method for learning the true condition of the

articulation, and they also show whether both articulations are involved and to what extent. The negative is placed against the side of the head, and the tube is adjusted so that the rays pass through the articulation in a direction obliquely upward, in this way avoiding the opposite ramus and angle, the shadow of which would not be as clearly defined as the ramus, which is in close contact with the negative.

As regards the practicability of the treatment employed, it is preferable to operate upon one side at a séance, choosing for the first operation the side most involved. Both articulations could be operated upon consecutively during the same séance. The advantages of this would be that the operator could satisfy himself, while the wounds were still open, that sufficient bone had been removed to obtain freedom of movement; the necessity of the second etherization would be avoided, and possibly there would be a lessened period of convalescence. Against this, however, is the increased danger from shock by prolonging the operation to just twice the length of time, as it is practically impossible to do synchronous operations; also the great danger of infecting the first wound, as it is very difficult to keep it protected from the fluids escaping from the mouth when the head is turned to that side while operating upon the opposite articulation. The wound in one week after operation will be sufficiently healed to obviate the danger of infection during a second operation.

The results in these cases depend largely upon the preservation of the function of the muscles of mastication; and it is important not to cut through the masseter muscles by a horizontal incision below the zygoma, as many operators have done. The method which is best is a vertical incision one and one-fourth inches in length, carried through the skin only, the fascia and fibres of the masseter muscles and the periosteum being split; this mode of division does not weaken the muscles to any appreciable extent. If the incision is limited to the skin, it is not possible to divide Stenson's duct or the temporofacial branches of the facial nerve. The temporary paralysis in each case was probably the result of overstretching of

the nerves. If special retractors are used, this method gives sufficient room for thorough and careful work. The function of the external pterygoid muscle is necessarily lost. Considerable lateral motion has been observed in many cases of unilateral ankylosis operated upon, due to the action of the opposite external pterygoid; but in bilateral cases lateral motion is frequently entirely lost. It is best to close the wounds without drainage when safe, as the facial contour is better preserved, especially if the muscles and fascia are held together by buried sutures. There is always considerable danger of the wound becoming infected when drainage is employed; and it is of the greatest importance to prevent infection, not only on account of its immediate danger, but also because it causes formation of a much greater quantity of cicatricial tissue, which will greatly limit the functional results; a depression inevitably results when drainage is employed. Some have packed the articulation with gauze for the purpose of keeping the surfaces of the bones more widely separated. When the wound is closed, the empty space will become distended with blood-clot, which will to some extent serve the same purpose; but if a wider separation of the false joints is desired, it is better to employ the method suggested by Cabot, of placing wedges of cork between the posterior teeth to maintain separation. Although this method was not used in the above cases, it seems to have special advantages, and should be used when practicable.

The most important question of all is the consideration of the dangers to be anticipated, and how to meet them.

I quite agree with Ranke, who said the greatest danger is from asphyxia; and I heartily sympathize with any operator who is confronted with this difficulty. In studying these two cases, I have endeavored to explain the occurrence of this condition in so serious a form in one, and to so slight an extent in the other. The ages of the patients were practically the same; they were both in good general physical condition, and the same care and technique were employed in each. The following reasons exist for believing that asphyxia is dependent

upon mechanical conditions, and a knowledge of them may be of some help in anticipating its occurrence in the future.

The normal position and function of the larynx are dependent upon the muscles which suspend it, the anterior group being connected with the mandible. It is reasonable to infer that the earlier in adolescence that development of the mandible ceases, the more abnormal will be the position of the tongue and larynx. In consequence of the mandible maintaining a fixed position in relation to the head while ankylosed, the muscles connecting the hyoid bone, the tongue and epiglottis, with the mandible, are accustomed to perform their functions with a limited power of contraction. If the mandible is dropped to a very slight extent, you can readily see how the functions of these muscles would be greatly disturbed. The relative difference in the two patients is quite marked and easily demonstrated. The first patient was eight years of age when the injury occurred, and the second five; and, although the subsequent development of the mandible practically ceased, the three years' difference in the ages of the patients at the time of the injury has made a marked difference in the condition of each. In the skiagraphs of the first patient, the position of the head in relation to the cervical vertebra is about normal, the lower border of the mandible making an angle with the bodies of the vertebra, five degrees less than a right angle, and the hyoid bone is shown one centimetre below the border of the mandible. The skiagraphs in the second case show considerable extension of the head upon the cervical vertebra; there is an angle of five degrees greater than a right angle, and the hyoid bone is seen three centimetres below the lower border of the mandible. The position of the hyoid bone is two centimetres lower in its relation to the mandible in the second case than in the first. The displacement of the larynx, hyoid bone, and the base of the tongue can be approximately estimated by the following measurements: there are one and one-half inches of the trachea above the manubrium, which can be increased on extension to one and three-quarters inches; in an adult there should be an average of two and

three-quarters inches; at ten years of age there should be two and one-quarter, and at six about two inches. The cricoid cartilage is opposite the body of the seventh cervical vertebra instead of the sixth. Therefore it is a reasonable calculation that the position of the base of the tongue, hyoid bone, and larynx is one inch lower than it normally should be, and their position remains practically the same in their relation to the manubrium as it was when the injury occurred, at five years of age. There are, I believe, two factors, both dependent upon the arrested development of the mandible, to which the faulty position of these organs is due. The position of the larynx and base of the tongue is dependent upon the position of the hyoid bone, it being suspended from the base of the skull by a duplicate set of muscles, namely, the stylohoid, the posterior belly of the diagastric, and the middle constrictor of the pharynx; and from the mandible by the geniohyoid, the mylohoid, and a portion of the geniohyoglossus, and the anterior belly of the diagastric. We will recall the fact that the position of the chin is one and three-eighths inches posterior to the position it normally should occupy, therefore it is evident that, if the chin should be carried forward to its normal position, the anterior group of muscles acting from that point would raise the hyoid bone at least one inch, which would be its normal position. And of still greater importance is this: that it would not only raise the hyoid bone, but would carry it forward, and with the bone the base of the tongue and larynx would be carried away from the posterior pharyngeal wall. The importance of this as regards the function of these organs, you will readily appreciate. I have gone into these details in order to make clear that, in the present condition of the patient, the hyoid bone with the organs which depend upon it for their position are not only displaced downward to the extent already given, but are also displaced backward, leaving practically very little pharyngeal space; and when the mandible is lowered to a very slight extent, the base of the tongue and the posterior surface of the larynx lie in contact with the posterior pharyngeal wall, making respiration very

difficult. I have frequently demonstrated this fact by retaining the mandible in a depressed position by means of the mouth gag, when the patient would become partly cyanosed and make violent efforts at respiration. At first I was inclined to believe that the obstruction to respiration was due to closure of the glottis by the epiglottis, the control of which having been lost by the changed position of the hyoid bone, as the movements of the epiglottis are practically dependent upon the position of that bone. It would be folly to attempt to exclude this as a factor, but I am strongly of the belief that the obstruction to respiration is due to the crowding of the larynx and base of the tongue against the posterior pharyngeal wall, leaving no space for air to reach the glottis, and, as a natural consequence, the epiglottis is forced against the glottis. In favor of this view are the following observations made at the time of operation. The respiration did not become impeded until the mandible was completely detached, in other words, until it dropped one-quarter of an inch; and it did not entirely cease until the mandible was depressed about one-half an inch by means of the mouth gag. Traction upon the tongue with the mandible depressed was of no avail, and it could not be while the base of the tongue was crowded against the pharyngeal wall.

How are we to anticipate the danger of asphyxia in any special case before operation? The first practical point would be the age at which ankylosis occurred, and at which the development of the mandible ceased. But this in itself has little significance if the operation is done soon after the occurrence of ankylosis, as the displacement of the hyoid bone, base of tongue, and larynx evidently increase with growth and reach the maximum at adult life. Consequently, the danger of asphyxia would increase in proportion to the time intervening between the occurrence of the ankylosis with arrested development and maturity. Further, ankylosis occurring after maturity would not cause any displacement or abnormality of the larynx, hyoid bone, and tongue, and consequently there

would be no more danger of asphyxia than in any ordinary case.

Upon this important part of the subject I consulted by letter one who is recognized as an authority, Dr. Thomas Dwight, Professor of Anatomy in the Harvard Medical School, whose recent very valuable contribution upon the "Growth of the Face and especially the Pharynx" bears directly upon this subject. I quote the following from his reply:

"I am quite of your opinion that the very serious danger in your case was caused by the tongue (carrying the epiglottis with it) falling back and obliterating the pharyngeal space. I think it is not generally recognized how very small that space is under any circumstances, as it is well shown on frozen sections in the median line. Very probably in your patient the space was even smaller than usual.

"I cannot, however, agree with you concerning one point. You suggest that the want of development of the mandible was the cause that the hyoid was not carried up to its normal position. The fact is that in the infant the hyoid and larynx are very high and gradually descend, and for that matter the lower jaw descends too, for at birth its lower border is nearly in the same horizontal plane as the occiput. Consequently its function is not to pull the hyoid up. The uncommonly low position of the hyoid is a puzzle. So far as I know, it must be extremely rare. Can it be that the want of development of the jaw in some way failed to restrain its descent? I own I do not see how this should occur. I am sorry that this is all I can say."

I would answer the above question in the affirmative, believing that it is the proper solution. As already described, the bringing of the occipital and mandibular attachments of the muscles which suspend the hyoid bone closer together allows the muscles to assume an almost vertical instead of an almost horizontal position; and, again, the growth of the tongue would necessarily displace the hyoid bone downward, owing to the fact that it could not extend anteriorly on account of the teeth in an ankylosed and undeveloped mandible.

The external measurements of the mandible are as follows: between angles nine and one-half centimetres; between angle and symphysis seven and one-tenth centimetres; between angle and zygoma four and one-half centimetres. Therefore not only the anteroposterior measurement, but the lateral measurement, was lessened, which, with the inward displacement of the teeth, would greatly restrict the space normally occupied by the tongue. My attention was called to this lateral narrowing of the pharyngeal cavity by Dr. D. Braden Kyle, who made an examination of the pharyngeal space, and coincided with the above views as to the cause of asphyxia. Having considered the age of the patient and its significance, a carefully elicited clinical history will aid materially in anticipating the danger of asphyxia. In Case II, ordinary respiration was attended by considerable stertor, and during the entire period in which the mandible was ankylosed he was never known to sleep without snoring loudly. To secure sleep he would generally assume the prone position, with the head turned to one side and extended over a pillow, or, if in a supine position, he would place one or two pillows beneath his shoulders, thus placing the head in full extension. In each of these positions he unconsciously followed the advice of Dr. Howard of London, who claims that "the best way to raise the epiglottis is not by pulling the tongue forward, but by extending the head and neck."

The necessity for full extension of the head during these years explains the acquired faulty position of the same with the vertebra, as shown in the skiagraph, and as already described, together with a marked prominence or anterior projection of the bodies of the first and second cervical vertebra, against which the soft palate is closely drawn.

Having considered at some length the dangers to be anticipated, the question of how to meet these dangers is of vital importance. When the danger of asphyxia is imminent, the absolute necessity of using the mouth gag while the patient is under the anæsthetic is disproved by the results in the two cases reported. In the second case the condition is quite satis-

factory and equally as good as in the first case. This demonstrates the practicability of obtaining sufficient stretching of the muscles and fascia subsequent to the operation. In any case, where more active use of the mouth gag is required, the metal shields should be used to cover the teeth. Greater force can then be applied. This plan was originally recommended by Dr. Goodwillie, of New York. (*New York Medical Journal*, July, 1875.)

To relieve asphyxia when present, instead of attempting to further depress the mandible, to make traction upon the tongue or reach the epiglottis as was done in my case, at once restore the mandible to the position it occupied when ankylosed, and thus place the parts in the best possible condition for easy respiration. In addition, if necessary, hook a tenaculum under the hyoid bone and lift it away from the posterior pharyngeal wall. This means failing, do a quick laryngotomy. The low position of the hyoid bone and the corresponding small amount of trachea above the manubrium would have rendered in my case a tracheotomy both difficult and dangerous, and hardly practicable in such an emergency. It is scarcely necessary to state that, in conjunction with different means employed, artificial respiration should be continued and all other necessary aids be used.

The clinical history of Case II would be incomplete without giving briefly the condition of the mouth, nose, and throat when examined subsequent to the operation. Besides several cavities in the remaining teeth, the first four molars were so badly decayed that practically only the roots remained, and these were extracted about three weeks after the operation. The second lower molars are opposite to the anterior angle, and are in a horizontal position, the crowns looking inward and towards each other. These teeth were so far within the arch that it was not possible to determine their presence until after the mouth was opened. For the care of his nose and throat, he consulted Dr. Walter J. Freeman, who very kindly sent me the following report of the condition which he found:

"After your operation . . . I found his difficulty in

breathing due to the adenoids and relaxation of the soft palate. The velum lay on the back of the tongue, and the uvula was so broad that the faucial opening was almost completely shut off from the throat. View of the vault could not be obtained through the throat, but the obstructing mass of pharyngeal tonsil could be plainly recognized through the nasal fossæ. I amputated the uvula, and the noisy respiration was immediately improved. With a snare I then removed a mass of the adenoids through the nose, and operations on this were continued by my associate, Dr. Baldwin, until the vault was completely cleared."

What prophylactic measures can be used to prevent possible ankylosis in cases of severe injury to the mandible similar to the two cases here reported? A careful examination of the mandible in the regions of the articulations will frequently disclose a fracture which, when present, should invariably be treated with an interdental splint with a closed bite, or the application of Dr. Angle's system of treating fractures with the teeth in occlusion. By either plan the fragments will be maintained in their proper relation to each other and be carried away from the zygoma, the danger of ankylosis being thus obviated. In seven cases so treated there was no appreciable interference in the movement of the mandible.

Of all the operations and methods resorted to in the past for treating permanent ankylosis of the mandible, only two are now being generally employed.

Excision of the head and neck of the condyle was first performed by Professor Humphrey, of Cambridge, in 1856 (*Medical Association Journal*, 1856), for the relief of ankylosis due to chronic rheumatic arthritis. The other operation is known as Esmarch's, who suggested it at the Congress of Göttingen in 1855. It was first successfully performed by Dr. Wilms in 1858. It consists in establishing a false joint in front of existing cicatricial tissue.

I cannot agree with David M. Gregg (*Practitioner*, De-

cember, 1899), who says "the only operation worth considering is excision of the neck and condyle;" nor can I agree with the conclusion of Dr. Paul Swain (*Lancet,* July 28, 1894). "Taking, therefore, into consideration the simplicity of the operation as compared with the excision of the condyle and the superiority of the results, I think it may fairly be suggested that the modifications of Esmarch's operation is the one which surgeons in the future should prefer." I do, however, practically agree with the opinion expressed by Dr. A. C. Cabot (*Lancet,* August 7, 1897), "in cicatricial contraction due to noma, burns, or lupoid inflammation, the section of the bone must be in front of the cicatrix, forming a false joint in front of the detaining bands; Esmarch's operation producing the best mechanical condition possible. In bony ankylosis, the nearer the section is made to the joint, the nearer do the conditions simulate the normal."

The condition of the articulation and the surrounding tissue is the proper guide in deciding which operation to employ. In the absence of cicatricial tissue, as in my two cases, or when the tissue is present in such small amount that there is a reasonable assurance that it can be overcome by appropriate treatment, excision of the head and neck of the condyle is the proper operation. Where the muscles are destroyed or their function is held in abeyance by dense cicatricial tissue which cannot be overcome, the Esmarch's operation is clearly indicated and gives the best results. The preservation of the maximum amount of muscular function in bilateral cases is of the greatest importance. In unilateral cases it is quite possible to have good masticating power from the muscles of the uninvolved side, even if Esmarch's operation is done upon the opposite side and in front of the masseter and internal pterygoid. But when Esmarch's operation is done in bilateral ankylosis, the power of mastication is very feeble or is lost; and in one case reported the central portion of the mandible was so beyond the control of the elevator muscles that for two days after the operation it caused grave danger of asphyxia by its depressed condition.

Of considerable concern to me was the question whether new bone would form from the periosteum after excision of the head and neck of condyle, which would subsequently lessen the range of motion. The results in these two cases and in the others reported demonstrate that this danger is scarcely to be apprehended, and that it is perfectly safe to make a subperiosteal excision.

THE ANATOMY OF THE INFERIOR ETHMOIDAL TURBINATE BONE WITH PARTICULAR REFERENCE TO CELL FORMATION; SURGICAL IMPORTANCE OF SUCH ETHMOID CELLS.

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Method of Investigation.—The results presented below are based upon a study of about 1000 specimens obtained in the dissecting-room and the Warren Museum of the Harvard Medical School. Most of the specimens represent dissecting-room material intact and in a good state of preservation, and the balance consists of about seventy skulls in which the bony outer wall of the nasal fossa was not broken. Some of the specimens were studied before and after maceration. In no instance was the clinical nasal history known. I am indebted to Professor Thomas Dwight for the opportunity to carry on this investigation. I owe much to Percy Emerson Brown, M.D., for his skill in obtaining photographs of the specimens.

Nasal Fossa.—The nasal fossæ are two more or less symmetrical cavities placed side by side and separated from each other by the septum of the nose which forms the internal wall in either instance (Figs. 9, 11, and 13). The fossa is open in front and behind at the anterior and posterior nares and is bounded above and below and laterally by four walls. The floor is much wider than the roof and the lateral walls are the most extensive. The nasal fossæ are surrounded by four other fossæ,—above is the cranial fossa; laterally, the orbital fossæ; and below, the cavity of the mouth.

The floor of the nasal fossæ will not be considered. Certain features of the roof and internal wall which bear important relations to the inferior ethmoidal turbinate will be referred to. The outer wall is not only the most intricate, but also is of

the greatest surgical importance. This outer wall is bounded chiefly by the internal surface of the body of the superior maxilla and its nasal process, and by the internal surface of the lateral mass of the ethmoid bone, but, in addition, this wall is completed by the nasal, lachrymal, and inferior turbinate bones, and internal pterygoid plate of the sphenoid bone (Fig. 1). The most striking feature of this wall is its irregularity made by two large bony projections called the inferior turbinate bone and the inferior ethmoidal turbinate ("middle turbinate"). There are always one or more lesser projections which are called superior turbinate bodies, but these are of little clinical importance.

The ethmoid bone is usually described as presenting a median vertical plate (lamina perpendicularis) which forms part of the nasal septum, and across the top of this is a horizontal, perforated plate (lamina cribrosa) which separates the nasal and cranial fossæ. On either side of the lamina perpendicularis, suspended from the lamina cribrosa, is a cuboidal, cellular mass of bone called the "lateral mass." The outer wall of the lateral mass is bounded by a flat plate of bone, called the os planum, forming part of the inner wall of the orbit. The inner wall of this lateral mass is very irregular and forms a part of the outer wall of the nasal fossa. The irregular bony cells between these two walls constitute the greater portion of the anterior and posterior ethmoidal cells (Figs. 9, 11, and 13). All the ethmoidal turbinate bodies or bones are projections from this internal wall (Fig. 1). The lower projection is called the inferior ethmoidal turbinate ("middle turbinate"), and is the structure under particular consideration in the following pages.

Internal Wall of the Lateral Mass (Figs. 1–6, 15, and 16).—The internal wall of the lateral mass is a more or less quadrangular area of bone, which serves both as an internal boundary for many of the ethmoid cells and likewise as a portion of the external wall of the nasal fossa. It consists entirely of a portion of the ethmoid bone. The upper border corresponds to the line of junction of this surface and the lamina

FIG. 1.—Outer bony wall of right nasal fossa; dotted line marks its roof. *F*, frontal sinus; *S*, sphenoidal sinus; *n*, nasal bone; *n.p.*, nasal process of superior maxilla; *s.p.*, sphenopalatine foramen; *m.t.*, middle turbinate; *O*, operculum; *g*, deep groove in middle turbinate; *f.e.i.*, fissura ethmoidalis inferior; 1 and 2, two superior turbinate bones with a deep middle ethmoidal fissure between them; *m.m.*, middle meatus; *i.t.*, inferior turbinate; *i.m.*, inferior meatus.

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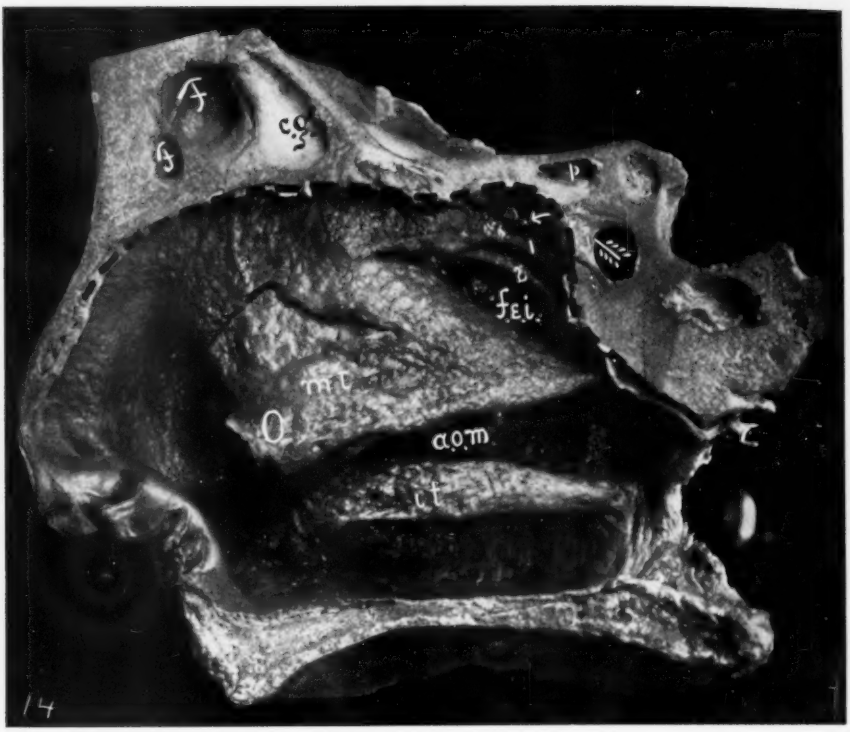


FIG. 2.—Outer wall of right nasal fossa; dotted line marks its roof. *F, F*, frontal sinus; *c.g.*, crista galli, which is hollow and communicates with the frontal sinus; *p*, posterior ethmoid cell. Arrow passes from a sphenoidal sinus through its ostium sphenoidale. *m.t.*, middle turbinate relatively very large. Mucous membrane hypertrophied. Inferior border, fifty millimetres; anterior border, thirty-three millimetres; height of nasal fossa, forty-six millimetres. *O*, operculum prominent; 1 and 2, two superior turbinate bones with a middle ethmoidal fissure between; *f.e.i.*, inferior ethmoidal fissure; *a.o.m.*, accessory ostium maxillare; *i.t.*, inferior turbinate.

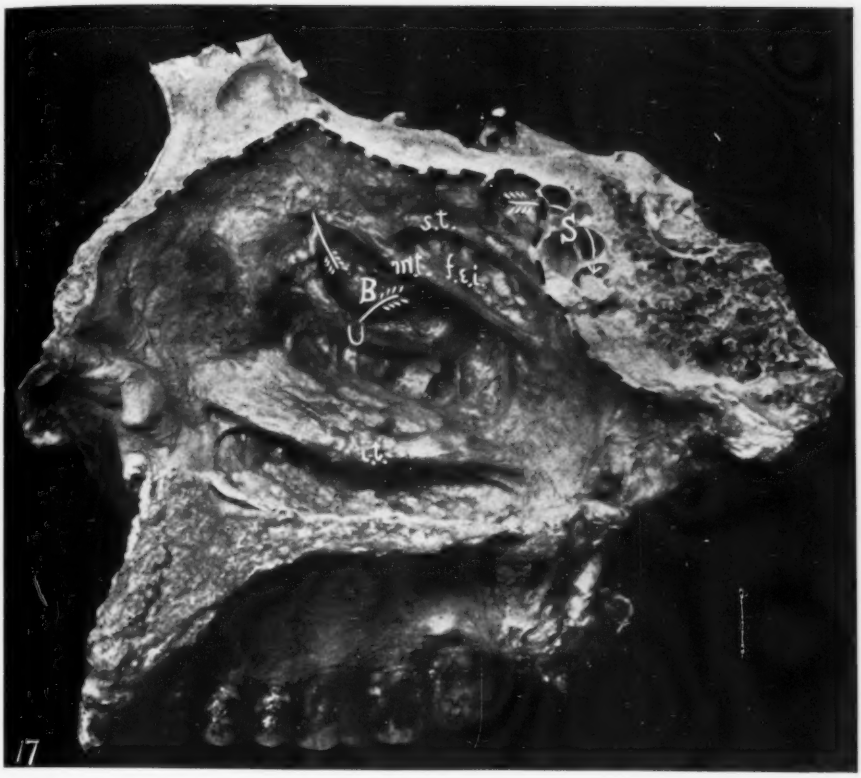


FIG. 3.—Outer wall of right nasal fossa showing an extreme degree of atrophy; dotted line marks roof of fossa. *S*, sphenoidal sinus, small and subdivided by cellular partitions. Arrow enters sinus through the ostium sphenoidale; *s.t.*, much atrophied superior turbinate; *f.e.i.*, fissura ethmoidalis inferior; *m.t.*, extreme atrophy of middle turbinate which consists chiefly of a fold of membrane without bone tissue; *B*, ethmoid bulla, above which is its ostium; anteriorly is an arrow leading to the frontal sinus; *U*, uncinate process, behind which an arrow passes through the ostium maxillare to a very small antrum; *i.t.*, inferior turbinate.

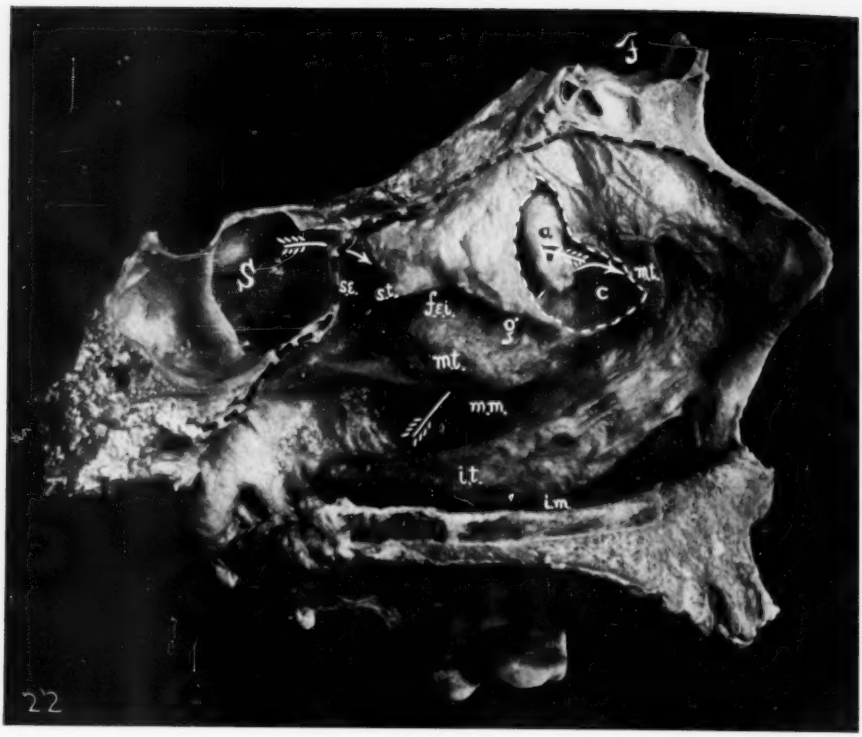


FIG. 4.—Outer wall of left nasal fossa; dotted line marks its roof. *F*, frontal sinus; *S*, sphenoidal sinus, arrow passes through its ostium; *s.c.*, spheno-ethmoidal recess; *s.t.*, superior turbinate; *f.e.i.*, inferior ethmoidal fissure prolonged as a groove (*g*) on the middle turbinate (*m.t.*); *m.m.*, middle meatus, with arrow passing into a large cell in the middle turbinate bone (*c*). The inner wall of this cell has been removed, exposing a swelling (*a*) which passes into this cell. This swelling is an unusually formed anterior ethmoid cell, into which an arrow is made to pass; it is fifteen millimetres long. The middle turbinate cell measures fifteen millimetres long, twenty-five millimetres high, and twelve millimetres wide. Inferior border of turbinate measures fifty-five millimetres, and the anterior border, thirty millimetres. *i.t.*, inferior turbinate; *i.m.*, inferior meatus.

cribrosa and is carried forward anteriorly on to the inner surface of the nasal process of the superior maxilla, and posteriorly to the ethmoid spine of the sphenoid bone. It is slightly convex towards the septum corresponding to the narrow portion of the roof of the nasal fossa (one to five millimetres). The inferior border is free and corresponds to the inferior border of the inferior ethmoidal turbinate (to be described later) and the anterior border of this surface corresponds to the anterior border of this turbinate. The posterior border is vertical and is the line of junction between this surface and the anterior surface of the body of the sphenoid bone. It forms a vertical groove and is called the spheno-ethmoidal recess.

The surface, as a whole, is rough, and its most striking feature is the presence of an oblique deep groove which, if continued, divides it into two triangles. The groove is known as the inferior ethmoidal fissure (all lateral views). The lower triangle is the inferior ethmoidal turbinate ("middle turbinate" of the nose). The upper triangle may present an intact surface, but is frequently subdivided by a fissure known as the superior ethmoidal fissure and rarely by another fissure (fissura suprema) (Fig. 1). According to the presence of these fissures there will be a variation in the number of superior ethmoidal turbinate bodies. This upper triangle forms the proper internal wall of most of the posterior ethmoidal cells. Its surface is somewhat convex towards the nasal septum, and posteriorly it looks backward towards the sphenoid bone. The surface is rough in consequence of numerous small vertical grooves and foramina for branches of the olfactory nerves.

Inferior Ethmoidal Fissure (Lateral views).—The inferior ethmoidal fissure is always present and runs obliquely downward and backward across the posterior half of this surface of the lateral mass. The anterior extremity starts just below the centre of the surface, about fifteen to twenty centimetres from the anterior border, and intersects the posterior border. Below, it forms the posterior part of the upper boundary of the inferior ethmoidal turbinate, and its upper border is made by the free edge of the next ethmoidal turbinate

("superior turbinate"). Its posterior extremity is open and ceases near the sphenopalatine foramen, but it is closed in front. Usually two or three posterior ethmoidal cells open into it by means of ostia which are apt to be larger than ostia of anterior cells. The floor of the fissure is made by the horizontal position of the inferior ethmoidal turbinate (Figs. 10 and 13) and looks upward and backward. It is comparatively broad and may extend to the os planum (Fig. 10). Pus from these cells is usually directed towards the pharynx. The fissure ends abruptly, but in certain cases it is prolonged as a shallow groove for a variable distance on the internal surface of the inferior ethmoidal turbinate (Fig. 4), or may be carried forward into the turbinate body itself and there dilated into a cell, as will be described later (Figs. 5, 15, and 16). The average inferior ethmoidal fissure measures twenty-six millimetres in length and about six millimetres in width.

Superior Ethmoidal Fissure (Figs. 1, 2).—This fissure is absent in at least 60 per cent. of the cases. When present, it has the same general direction as the inferior ethmoidal fissure. It is about half as long and is situated a short distance above it. It is a groove, deeper in the centre, and it terminates posteriorly in the spheno-ethmoidal recess. It is exceptional for it to possess the ostium of more than one posterior ethmoidal cell. In very rare instances there may be still another groove above this known as the "supreme ethmoidal fissure."

When only the inferior fissure is present, there are two ethmoidal turbinate bodies; the presence of the superior fissure adds a third body. Hence, counting the inferior turbinate bone, there are three turbinate bones, so called, in about 60 per cent. of the cases, and the presence of four such bodies is not unusual, but a fifth is very rare. Only the inferior turbinate bone and the inferior ethmoidal turbinate ("middle turbinate") have any real practical importance. The spheno-ethmoidal recess is a vertical groove just in front of the anterior surface of the body of the sphenoid bone where the ethmoidal fissures terminate behind, and into which opens the sphenoidal sinus.

Ethmoid Cells (Figs. 9, 11, 13, and 16).—The ethmoid

cells will be considered only in a general way. They are most conveniently divided into two groups,—the anterior and posterior cells. They are contained in whole or in part in some portion of the lateral mass of the ethmoid bone and completed by portions of facial bones, which need not be considered here. All cells whose ostia open below the inferior ethmoidal turbinate are called anterior cells, those which open above are called posterior cells. In a general way, the anterior cells are in front of the posterior cells, although they may overlap extensively. The division into a middle group situated opposite the os planum does not appeal to the writer.

The anterior cells have been described in a previous work * with considerable detail, and were summarized as follows:

A series of cells whose ostia are situated along two ethmoidal fissures (homologues), viz., along the hiatus semilunaris, and the fissure between the bulla ethmoidalis and the inferior ethmoidal turbinate. There are three groups of cells:

(*a*) A group represented by the bulla ethmoidalis and its subdivisions.

(*b*) A group of cells crowding into the posterior angle of the frontal sinus which drain into the infundibulum, the turbinate fossa, and the upper part of the fissure above the bulla.

(*c*) A group of cells opposite the lachrymal bone which drain into the infundibulum.

The Posterior Ethmoid Cells.—In general, these cells are situated behind the anterior cells. They are bounded internally by the internal wall of the lateral mass (Figs. 9 and 13), in the ethmoidal fissures of which are situated their ostia. Posteriorly these cells are in close contact with the sphenoidal sinus and may run back external to it. The sinus, however, always has its own ostium which opens into the spheno-ethmoidal recess. Externally these cells are limited chiefly by the internal wall of the orbital fossa. Above they enter a

* Lothrop, "Frontal Sinus and Anterior Ethmoid Cells," ANNALS OF SURGERY, 1898.

varying distance between the two laminæ of the horizontal portion of the orbital plate of the frontal bone (Fig. 2). They are larger and less numerous than the anterior cells and usually number from four to seven. There is a cell in front of the sphenoidal sinus, opposite the superior turbinate, which is generally the largest, and it may equal this sinus in size. The ostia of these cells are few. There may be one to three in the inferior ethmoidal fissure, and one in the superior fissure if this fissure happens to be present. These cells almost never open into the spheno-ethmoidal recess. The superior turbinate body may consist simply of a ridge of bone on the wall of a large cell (Fig. 10). There is sometimes a prominence made by this cell called the "tuberculum ethmoidale posticum." A posterior cell may communicate with the cell of the inferior ethmoidal turbinate (Figs. 15 and 16). The total capacity of the posterior cells is usually less than that of the anterior, although, individually, they may be larger. Their ostia are so large and their drainage so good that they are less liable to be the seat of suppurative disease. The ethmoidal cells are absent at birth (Fig. 7), but develop slowly, and are not completely formed before the age of twenty years.

The Inferior Ethmoidal Turbinate (all lateral views).—The inferior ethmoidal turbinate bone is the antero-inferior triangle marked off on the internal wall of the lateral mass of the ethmoid by the inferior ethmoidal fissure and a line projected forward and upward to the anterosuperior angle of the surface. The lower part of the turbinate hangs more or less vertically as a free lamella of bone (Figs. 9 and 11). It is commonly called the "middle turbinate bone," but it is a part of the ethmoid bone, and is more accurately termed the inferior ethmoidal turbinate.

The general shape of this lamella of bone is triangular, and it presents for descriptive purposes two surfaces, internal and external; three borders, superior, anterior, and inferior, and three angles, posterior, superior, and anterior.

Internal Surface.—The bony surface is rough, but when covered with mucous membrane it is comparatively smooth.

Fig. 5.—Outer wall of right nasal fossa; dotted line marks its roof; double cells in the turbinate. *F*, frontal sinus, membrane just exposed without opening the sinus; *S*, small sphenoidal sinus, with arrow through its ostium; *s.e.*, spheno-ethmoidal recess; *p*, posterior ethmoidal cell, with arrow passing through its ostium into the inferior ethmoidal fissure (*f.e.i.*); 1 and 2, two superior turbinate bones; *m.t.*, middle turbinate with operculum (O). Inferior border, forty-five millimetres; anterior border, twenty-eight millimetres. *c, c*, two cells in middle turbinate with inner wall removed. The anterior one opens into the middle meatus as shown by arrow; the posterior one opens into the ethmoidal fissure above the middle turbinate, and also communicates with the posterior ethmoid cells which extend to the roof of the fossa. The anterior cell is seven millimetres long, seventeen millimetres high, and five millimetres wide; the posterior cell is ten millimetres long, nineteen millimetres high, and six millimetres wide. *i.t.*, inferior turbinate; *i.m.*, inferior meatus.

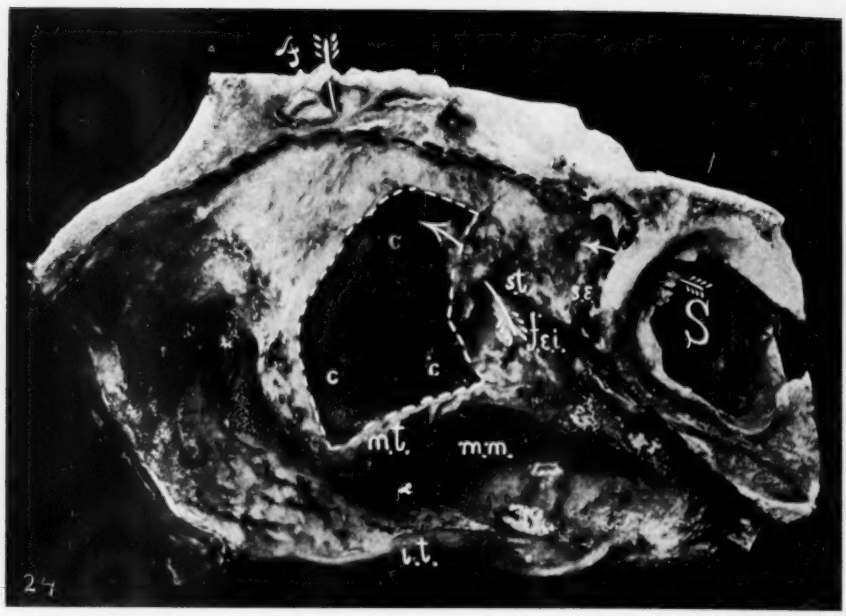


FIG. 6.—Outer wall of right nasal fossa exposing a very large hollow, middle turbinate. The inner wall removed, exposing its cavity (*c, c*), into which an arrow passes through its ostium from the inferior ethmoidal fissure (*f.e.i.*). This cell measures twenty-five millimetres long, thirty-one millimetres high, and fourteen millimetres wide. The height of the turbinate is thirty-five millimetres. *F*, frontal sinus, with arrow passing to middle meatus (*m.m.*); *s.t.*, superior turbinate; *S*, sphenoidal sinus, with arrow passing through its ostium; *s.e.*, spheno-ethmoidal recess; *i.t.*, inferior turbinate.

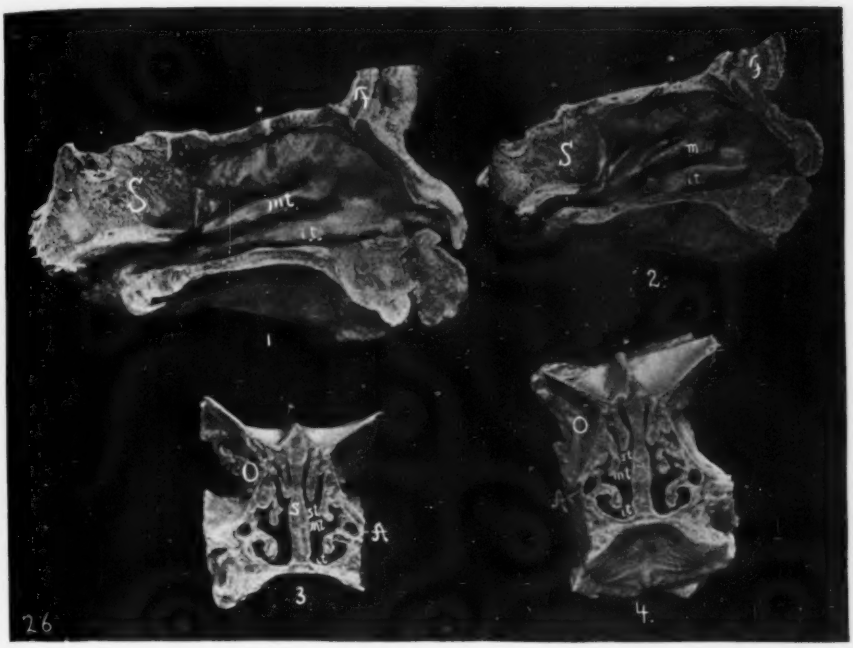


FIG. 7.—Nasal fossa of infant at birth; mucous membrane smooth and comparatively thick.

Nos. 1 and 2, outer wall of left fossa. *F*, cancellated tissue at site of undeveloped frontal sinus: *S*, site of undeveloped sphenoidal sinus; *m.t.*, middle turbinate; *i.t.*, inferior turbinate.

Nos. 3 and 4, transverse sections showing turbinates and meatuses. *O*, orbital fossa; *S*, septum nasi; *s.t.*, superior turbinate; *m.t.*, middle turbinate; *i.t.*, inferior turbinate; *A*, antrum.

FIG. 8.—Transverse section of right lateral half of a specimen just anterior to the ostium maxillare; the anterior half is rotated outward so as to expose both cut edges, left nasal fossa is intact. *O*, *O*, orbital fossa; *m.t.*, middle turbinate, anterior and posterior portions; *c*, *c*, corresponding halves of the large cell contained within the turbinate. An arrow marks its ostium into the middle meatus. It is so situated that its holding capacity for fluids with the head erect is considerable; *O*, operculum; *F*, frontal sinus, near which is an arrow entering the sinus just anterior to an anterior ethmoidal cell (*a*) which forms a frontal bulla. The posterior half shows the remaining part of this cell. *o.p.*, os planum of ethmoid bone; *A*, *A*, comparatively small antrum, with an arrow passing out of its ostium directly towards the frontal sinus; *U*, uncinate process, above which is a cell space carried forward and marked *a* in the anterior half and known as the infundibulum. *i.t.*, inferior turbinate; *s*, nasal septum, showing injected arteries.

It is triangular and narrow posteriorly, and presents a varying degree of convexity towards the septum. The anterior and upper portion is rather flat, but inferiorly this lamella of bone curves sharply outward. At the inferior ethmoidal fissure this surface turns a sharp angle so as to form the floor of the fissure, and here it faces upward and backward (Figs. 10 and 13). Its length depends upon that of the fissure, and its breadth is commonly that of the lateral mass. It may be separated from the orbital fossa by the inner wall of the latter, or some posterior ethmoid cells may intervene. It may be twelve to thirty millimetres long and ten millimetres wide. This surface directs the pus from these cells into the pharynx. Towards the lower part of the internal surface are grooves for branches of the sphenopalatine artery.

The surface, as a whole, is rather smooth, but occasionally presents well-marked horizontal grooves which are in the centre of the surface, and do not extend into the ethmoidal fissure (Figs. 4 and 7). If very deep, they form a well-marked gutter, and if broad, they tend to reduce the normal convexity of the surface. The anterior extremity occasionally terminates in a pocket, but never in a distinct cell. In only one instance has there appeared a "middle turbinate" which presented a true internal concavity rather than a convexity (Fig. 12). Unlike the external surface, there are no cells on it. It is unusual for a groove to measure more than twenty millimetres long by three millimetres deep and three millimetres wide. They are rarely multiple. The lips of a prominent groove can be observed from the anterior nares and the region explored with a probe.

Occasionally the internal surface may present one or two elevations. The lamella at the agger nasi may be unusually elevated so as to make a prominence called the "tuberculum nasoturbinale," which is simply a well-marked agger nasi. When the superior and inferior ethmoidal turbinates meet at the beginning of the inferior ethmoidal fissure there may be a prominence made by an ethmoid cell; this is called the "tuberculum ethmoidale anticum." The "tuberculum ethmoidale posticum" has been noted in connection with the superior turbinate.

arrow passing out of its ostium directly towards the frontal sinus; *t*, uncinate process, above which is seen the ostium maxillare; *i.t.*, inferior turbinate; *s*, nasal septum, showing injected and marked *a* in the anterior half and known as the infundibulum. arteries.

Internal to the turbinate is the septum nasi, with which it should not be in contact. Usually there is a space of two to five millimetres between them called the olfactory fissure (Figs. 9 and 14). They may be in contact as a result of a malposition of the turbinate or because it contains a large cell, or there may be a deviation of the septum or a cartilaginous or bony spur. It is a clinical observation that the development of the turbinate depends upon the amount of space necessary to fill. For example, if the septum is crowded to one side so as to touch the turbinate, this body is apt to recede, and the two surfaces do not remain in contact. Meanwhile, the concavity on the opposite side of the septum is more or less filled by a compensatory hypertrophy of the opposite turbinate. Most of the increase is due to a hyperæmic condition of the turbinal covering. Opposite the greater part of the inferior ethmoidal turbinate is the lamina perpendicularis of the ethmoid. If the turbinate is large, it may be opposite the triangular cartilage; but the posterior extremity is always opposite the upper part of the vomer. As a result of trauma, the opposing surfaces may become adherent by bands varying in extent, particularly if both surfaces are wounded.

External Surface (Figs. 9, 11, and 14).—The external surface faces outward and presents in general a concavity most marked in the lower horizontal half. This is called the sinus of the turbinate (sinus turbinalis). Towards the superior angle the surface is flat, and near the posterior angle the upper portion of the surface looks downward and forward. This surface is rougher than the internal surface, and commonly presents depressions or pockets and orifices leading to cells which will be considered later.

The external relations of this surface are very important and complicated. Opposite the upper angle is a space which varies in size, and it has been termed the turbinate fossa. In 50 per cent. of all cases the frontal sinus opens here without communicating with the infundibulum (Figs. 9 and 11). Some of the ostia of anterior ethmoid cells are found here. Opposite the turbinate sinus are the bulla ethmoidalis, hiatus

semilunaris, and processus uncinatus. The outline of the bulla frequently corresponds to the concavity of the sinus, but the bulla may be flat, consisting of a simple lamina of bone, may be generally enlarged and symmetrical, or may be drawn out into a nipple-like process (Fig. 14). Hence, its proximity to the turbinate will vary. The general direction of the uncinate process conforms roughly to that of the free borders of the turbinate, but at the extreme upper limit of the anterior border of the turbinate these two structures are usually in contact. The average bulla is about ten millimetres long, and posteriorly its surface is continuous with the under surface of the turbinate. The relation between the bulla and sinus turbinalis is fairly constant, but the former may be so large as to fit into the sinus. Occasionally a band of mucous membrane passes across from one to the other.

The turbinate may be directed outward so sharply as to come in close proximity to the structures external to it, and may occasionally come in direct contact with them. The space may be narrowed, furthermore, by an hypertrophied condition of the mucous membrane or by the presence of polypi. These conditions are of great importance, for the ostia of different sinuses and cells may be obstructed thereby.

Superior Border.—This is the longest border, and it runs obliquely upward and forward across the internal wall of the lateral mass, dividing it into two triangles as mentioned above. It has a bony attachment throughout its extent. Beginning posteriorly at the sphenopalatine foramen, it crosses the superior turbinate crest of the palate bone, thence along the inferior ethmoidal fissure, whence it is continued in the same direction as an imaginary line to the cribriform plate, and then towards the median line to reach the internal surface of the nasal process of the superior maxilla. This is the superior angle. All of the lamina below this line is treated as the inferior ethmoidal turbinate for descriptive purposes. In the disarticulated ethmoid bone, the anterior border is very obvious.

Anterior Border.—This border extends from the superior angle downward to meet the inferior border at the anterior

angle. It is the shortest border. It passes downward for a variable distance on the internal surface of the nasal process of the superior maxilla, often in conjunction with the anterior extremity of the uncinate process. Thence it continues in a general downward direction as a free border, slanting forward or backward to reach the anterior angle. This free angular portion of the turbinate is called the "operculum" (Figs. 1 and 2). The prominence of the operculum depends upon the length of the free portion of this border. It is open to inspection from the anterior nares.

Inferior Border.—The inferior border connects the anterior and posterior angles. It is generally horizontal and is free for its whole extent. It is fairly regular and follows the outward curled portion of the turbinate. This border is thickened, grooved, and channelled for vessels, and towards its anterior end it contains at times dense bone tissue. The border may be deeply notched. The bone tissue is more dense here than elsewhere in the turbinate. A part of this border can be seen from the posterior nares (Fig. 10).

Posterior Angle.—This angle is at the junction of the superior and inferior borders and is situated just below the sphenopalatine foramen, close to the internal plate of the pterygoid process. The bony angle is flat, and, as a rule, it is not accentuated by the mucous membrane, as is the corresponding angle on the inferior turbinate bone. It is on the same level as the Eustachian tube and in the same vertical plane as the angle of the turbinate below. In contrast to the angle of the lower turbinate, a sling can rarely be made to catch on the posterior angle of the inferior ethmoidal turbinate (Fig. 5).

Superior Angle.—This is placed obscurely at the junction of the superior and anterior borders near the roof of the nasal fossa just internal to the ostium frontale. Just external to it is the turbinate fossa, which may be a comparatively wide space and contain the openings of the frontal sinus, the frontal bulla, and some of the anterior ethmoidal cells. Just below it is the prominence of the agger nasi, which corresponds to a turbinate in certain of the lower mammalia.

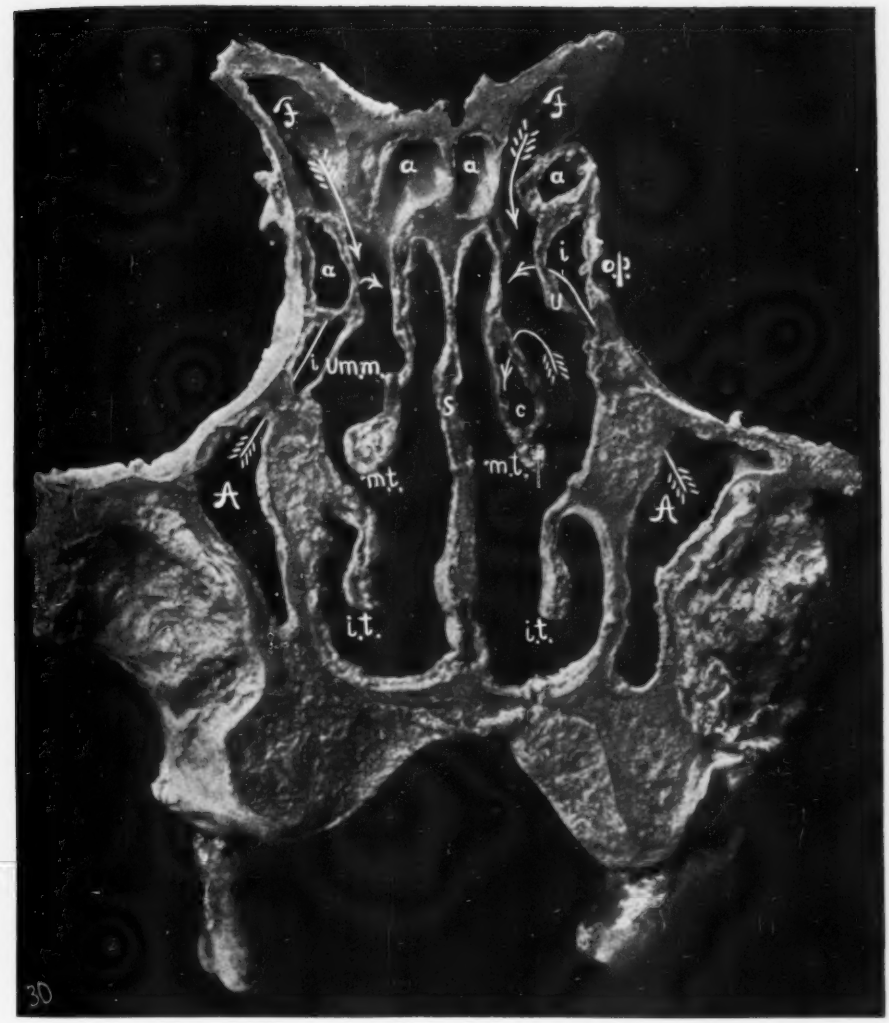


FIG. 9.—Transverse section just anterior to the ostium maxillare. *F*, frontal sinuses, with arrows passing through their ostia directly into the middle meatus without entering the infundibulum (*i*); *a*, *a*, anterior ethmoid cells; *A*, antrum. Arrows pass into the infundibulum (*i*) through the ostium maxillare, thence through the hiatus semilunaris into the middle meatus under the middle turbinate bone. *U*, uncinate process, which is placed obliquely and forms the internal wall of the infundibulum; *s*, septum nasi; *m.t.*, middle turbinate. On the left side this turbinate contains a cell (*c*) which communicates with the middle meatus, as shown by an arrow. *i.t.*, inferior turbinate; *o.p.*, os planum.

FIG. 10.—Transverse section at the posterior extremity of the middle turbinate bones. The section shows the horizontal aspect of the posterior half of the turbinate (*m.t.*). *S*, right sphenoidal sinus, with arrow passing through its ostium into the nasal fossa. Only a small portion of the left sinus appears, and to the left is a large posterior ethmoidal cell (*p*). *s.t.*, superior turbinate; *s*, septum nasi; *i.t.*, inferior turbinate.

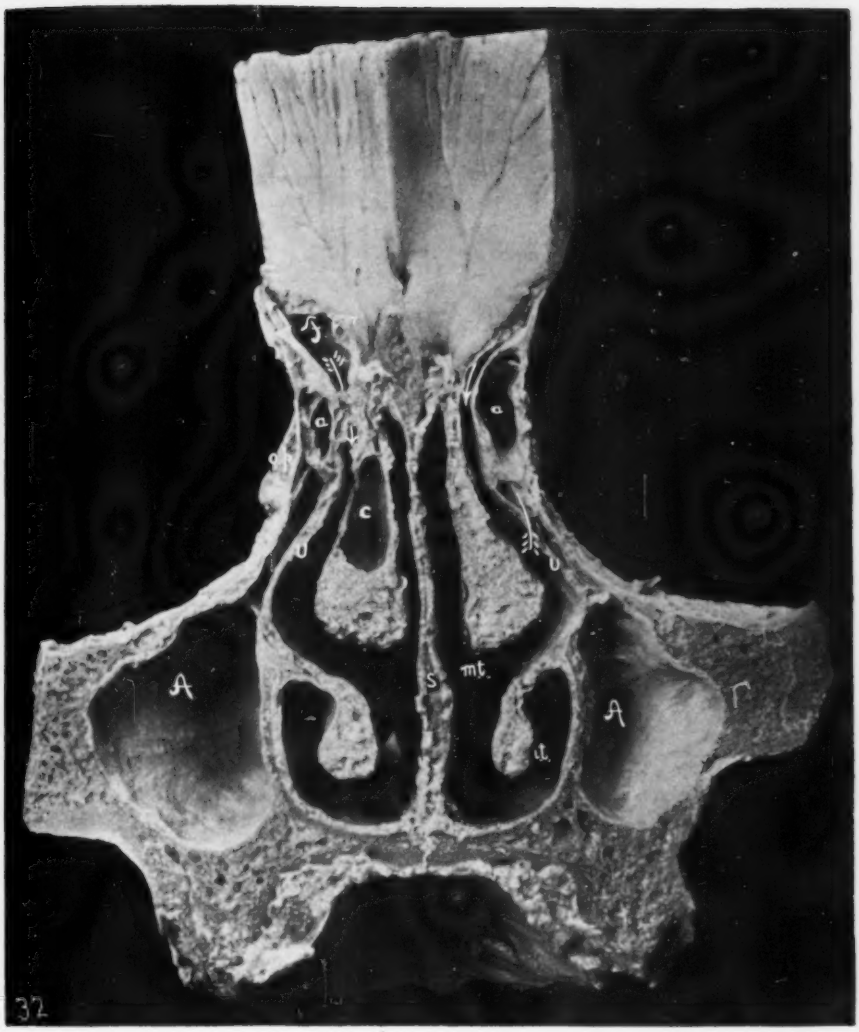


FIG. 11.—Transverse section at the ostium maxillare. *F*, left frontal sinus, with arrow passing through its ostium into the turbinate fossa. A similar arrow emerges from the right sinus. *o.p.*, os planum; *a, a*, anterior ethmoid cells; *m.t.*, middle turbinate bodies, unique in that they consist of very dense bone tissue measuring ten millimetres in width. They contain a cell (*c*) which is larger in the left turbinate, but the cell in the right turbinate is located so far posteriorly as to appear in the posterior half. *U*, uncinate process. On the right side an arrow passes forward in the infundibulum which ends blindly in a cell; *s*, septum nasi; *i.t.*, inferior turbinate; *A*, antrum.

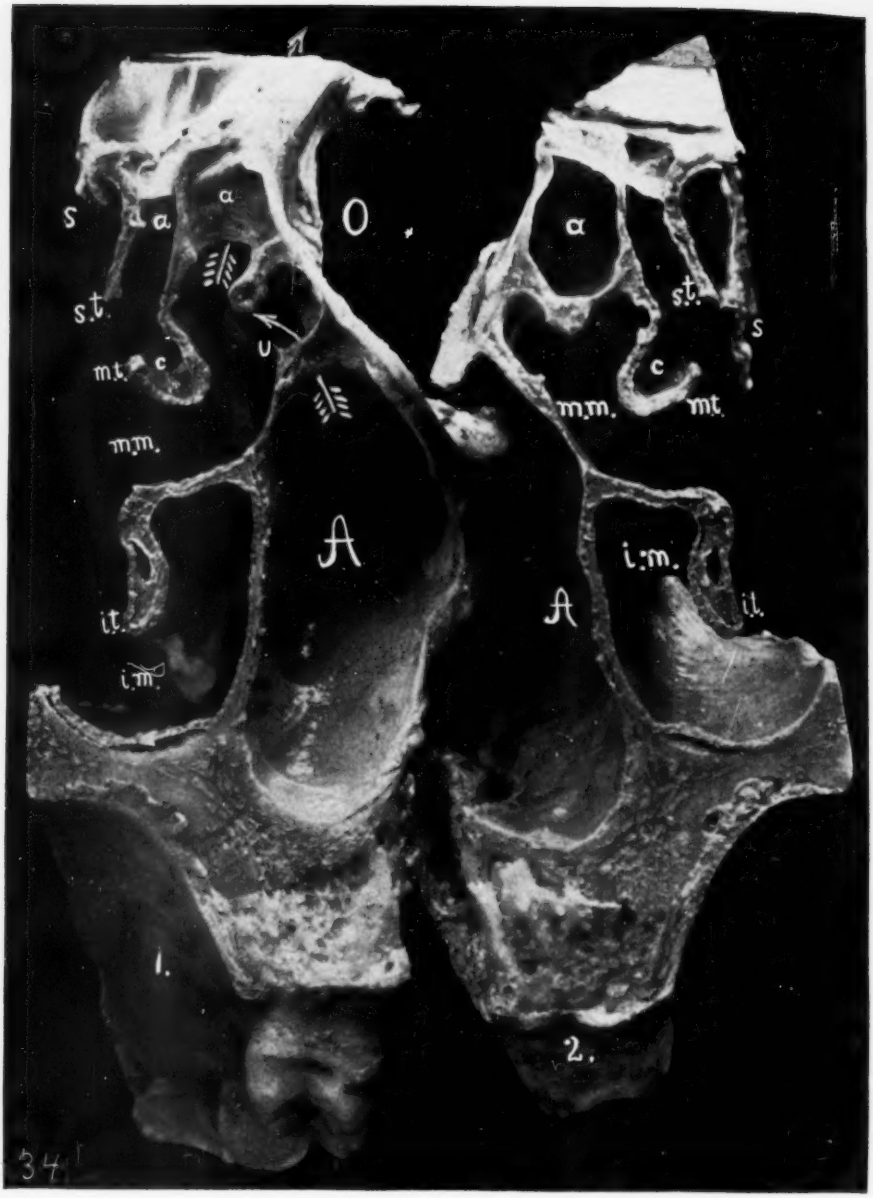


FIG. 12.—Transverse section of right nasal fossa, septum (*s*) fragmentary. The two halves of this specimen are placed side by side. 1, anterior half; 2, posterior half; *s*, septum nasi; *s.t.*, superior turbinate; *a*, anterior ethmoid cells. In 1 an arrow passes forward from the turbinate fossa into the frontal sinus, and a second arrow from the antrum (*A*) into the infundibulum; the antrum is large. *O*, orbital fossa; *m.t.*, middle turbinate in this specimen is unique in that it presents a deep concavity (*c*) on its internal surface; *m.m.*, middle meatus; *i.t.*, inferior turbinate; *i.m.*, inferior meatus.

Anterior Angle.—This angle is at the junction of the anterior and inferior borders. It is the only free angle, and its prominence depends upon the length of these borders; hence, it may be more or less than a right angle (compare lateral views). This portion of the turbinate acts as a sort of cover and is called the "operculum." It is open to inspection from the anterior nares. It may be thick or thin, and is much dilated by an extensive cell formation which has been termed "concha bullosa." The operculum hangs vertically, and may be directed outward or inward.

General Structure and Variations of the Turbinate.—The bony lamella is comparatively thin, particularly at its point of greatest convexity, but along the inferior and anterior borders it is frequently very dense. Throughout the greater part of its extent it is not thicker than an egg-shell, and contains numerous perforations (Fig. 1). The turbinate in the aged are extremely thin and brittle. One specimen (Fig. 11) is unique, and the only example found in which the turbinate is made up of comparatively thick, dense bone.

Variations in the outline have been noted, likewise the occurrence of one specimen which presented a concavity towards the septum (Fig. 12). There is considerable uniformity in size. A relatively large turbinate is shown in Fig. 2.

The turbinate may appear to be absent, as seen in Fig. 3, but in every instance there is either a bony ridge or membranous flap to mark its presence. Ordinarily, when viewed laterally, the bulla and uncinate process cannot be seen, but not infrequently the uncinate process is exposed, and only in cases of extreme atrophy is the inferior border of the turbinate higher than the bulla (Fig. 3). The middle turbinates of opposite sides are never precisely alike, and they often present marked asymmetry (Figs. 9 and 11). The cellular structure will be considered below.

The inferior ethmoidal turbinate is covered with a thin periosteum, a small amount of loose connective tissue, outside of which is mucous membrane possessing ciliated, columnar

epithelium. In the mucous membrane and the connective tissue, especially on the internal surface and lower border, are numerous cavernous spaces which can be filled with blood. The various passages can be thereby much narrowed. The condition is known as hyperæmia, and this tissue is an example of " erectile tissue." Ciliated mucous membrane lines the structures which have been considered above, including all the cells connected with the ethmoid bone.

The blood supply of the middle turbinate is derived chiefly from branches of the sphenopalatine artery, and these run forward along the inferior portion, forming an extensive anastomosis.

The sensory nerve supply is derived chiefly from branches of the superior maxillary division of the fifth pair of cranial nerves. A few branches of the olfactory nerve are distributed in the vicinity of the superior angle, extending down a short distance on the internal surface of the turbinate.

Cells of the Inferior Ethmoidal Turbinate (Figs. 4, 5, 6, 8-14, 15, 16).—Ordinarily, the middle turbinate consists of a thin, curved lamella of bone which is a part of the ethmoid bone. It is thinnest opposite the sinus turbinalis, and its thickest portion is along the inferior and anterior borders in the vicinity of the inferior angle. This thickened portion may be more or less cancellated and tunnelled for vessels, and is sometimes of sufficient width as to present an inferior surface. Small exostoses sometimes occur.

As will be seen below, it is a common occurrence for this lamella of bone to contain cells of different sizes and shapes, located in different portions of the turbinate. A cell located in any portion of the turbinate can be properly called a middle turbinate cell, and all such cells will be considered below. These are strictly ethmoid cells and could be classed as anterior or posterior, as will be observed below.

There is much confusion in the literature as to the origin and nature of these cells, which I believe is due primarily to a lack of investigation of a large number of normal turbinates, and, secondarily, to errors by clinicians who remove portions

of cell walls which have been changed by pathological processes, and are led to believe that all such cavities are pathological. They are usually described as "osseous cysts." In anatomical works the first mention of cells of the middle turbinate was made by Santorini, and later similar observations were made by Zuckerkandl. So far as I can learn, no other very extended anatomical investigation has been made. Dupuytren appears to have made the first clinical report of middle turbinate cells.

As has been noted, the following statements and conclusions are based on the study of about one thousand middle turbinate bones, obtained from dissecting-room subjects and museum specimens. The turbinates of very few children could be obtained, but a considerable number of new-born infants were examined. By far the greater number of specimens represent the adult condition, including all ages. The sex in these cases was not followed closely, and there seemed to be no reason for believing that cells appeared more commonly in one sex than the other.

Age.—There are no ethmoid or middle turbinate cells at birth. The ethmoid cells begin to develop at about five years of age, but I discovered no turbinate cell in children. They were equally common in all ages of adults. Comparing the cells of all ages, they appeared to reach their normal development synchronously with the ethmoid cells, and then remained stationary unless altered by disease or the thinning of bone in old age.

Occurrence.—Of 1000 inferior ethmoidal turbinates, eighty-nine contained a cell, making about 9 per cent. of all cases. In a previous smaller series of cases, all of which are included in the above, the percentage was eighteen, hence it was a matter of chance that the early specimens contained cells. In 6.7 per cent. only a single cell was present, in 1.3 per cent. two or rarely more cells coexisted. In ten of the 1000 cases, or 1 per cent., both middle turbinates of the same subject contained cells. The cells were slightly more frequent in the right than in the left turbinate.

No cell was discovered in the inferior turbinate. In the superior turbinate region, the lamella of bone which constitutes this turbinate is often very thin and narrow, so that the turbinate is practically a strip of bone crossing a posterior ethmoid cell. The prominence of the superior turbinate often depends upon the size of a posterior ethmoid cell.

Location of Cells in the Turbinate.—Almost without exception the cell is situated somewhere in the anterior half of the turbinate. If it occupies any part of the posterior half, it is always one of the bullous type of large cells which occupies the anterior half as well (Figs. 6, 14, 15, 16). More commonly a single cell is located near the central part of the turbinate in the vicinity of the anterior extremity of the inferior ethmoidal fissure (Figs. 4, 5). When the cell is very large, the condition has been called "concha bullosa." Only in this type does the cell extend for any degree to the inferior border or to the inferior angle. In most cases there remains a strip of cancellated bone along the anterior and inferior borders (Fig. 9.)

Occasionally the cell may extend towards the superior angle, forming part of a large anterior ethmoid cell, thus reaching the roof of the nasal fossa. The frontal sinus may communicate thus with a cell in the turbinate. More often the turbinate cell communicates with a large posterior ethmoidal cell so as to reach the level of the lamina cribrosa (Figs. 6, 15, No. 6, and 16, Nos. 5 and 6). As a rule, the turbinate cell occupies a position between the anterior angle and anterior end of the inferior ethmoid fissure encroaching upon the area of the turbinate sinus from in front and above (Fig. 14).

Types of Cells.—Cells of the turbinate may be classified according to their size, small or large, or according to whether they open into the middle meatus or the inferior ethmoid fissure. The size of cell bears no relation to the situation of its ostium.

Small cells are common near the anterior extremity of the ethmoidal fissure, extending a variable distance into the turbinate; these open into the fissure, and they can be recog-

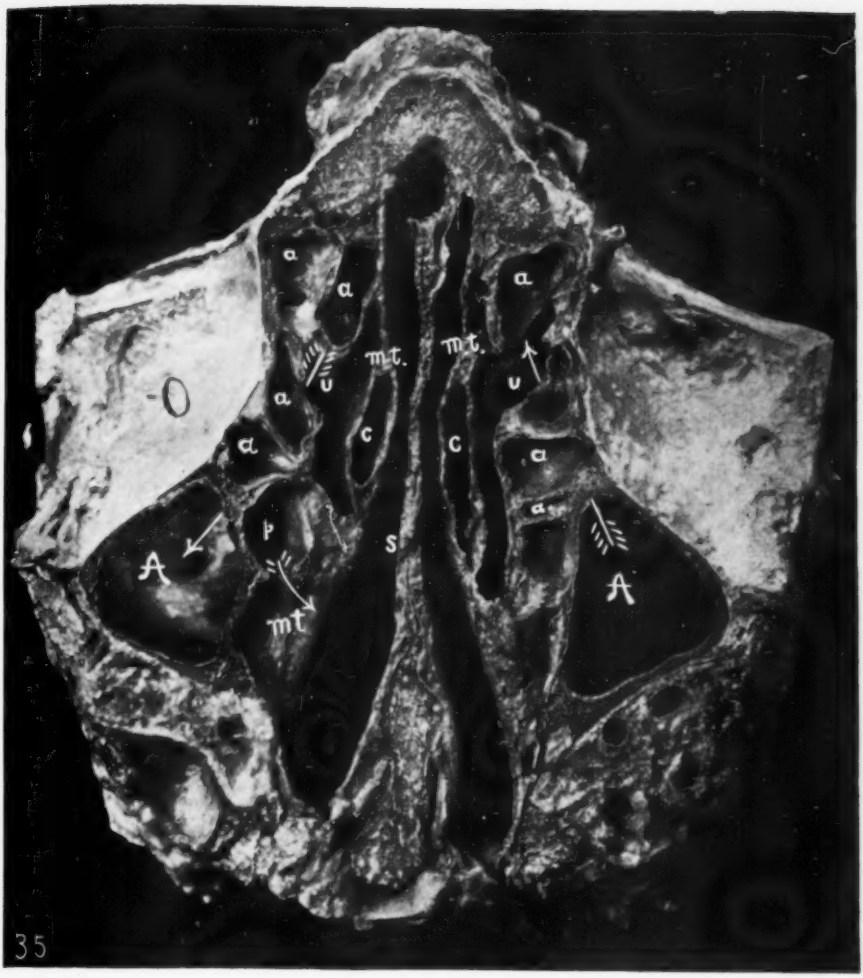


FIG. 13.—Horizontal section above the level of the ostium maxillare. *A*, antrum, with arrows indicating the position of the ostium maxillare and lying in the infundibulum; *U*, uncinate process; the cavity just external to the letter is the infundibulum; *a*, *a*, anterior ethmoid cells; *p*, posterior ethmoid cells; *s*, septum nasi; *O*, orbital fossa; *m.t.*, middle turbinates. The posterior half of each turbinate is horizontal; the anterior half is vertical, and in each instance the turbinate contains a cell (*c*). The dark space external to these turbinates is the middle meatus, and the long, dark area internal to the turbinates divided by the septum is the general cavity of the nasal fossa.

FIG. 14.—Lateral view of middle turbinates still covered with mucous membrane. A dotted line along the upper border shows the line of attachment to the lateral mass of the ethmoid bone. The cavity of cells (*c*) has been exposed by removing a portion of the lateral wall. *s*, sinus turbinalis. Portions of the superior turbinate appear in Nos. 4, 7, 10, and 13.

1. External wall of right turbinate; arrow passes into a cell through its ostium from the middle meatus.

2. Internal surface of left turbinate marked by a deep groove (*g*).

3. External surface of right turbinate; arrow passes through a large ostium into a cell which occupies the anterior half of the turbinate.

4. External wall of left turbinate. *a* and *p* represent the broken ethmoid cells; *B*, ethmoid bulla, with arrow entering the cavity through its ostium.

5. External wall of right turbinate showing a cell which occupies the anterior half of the turbinate opening into the middle meatus.

6. External wall of right turbinate which contains a cell occupying the anterior third of the turbinate.

7. External wall of left turbinate, the middle third of which contains a cell.

8. External wall of right turbinate containing a cell which occupies the greater part of the turbinate. It opens into the middle meatus. It measures twenty-nine millimetres long, nineteen millimetres high, and ten millimetres wide.

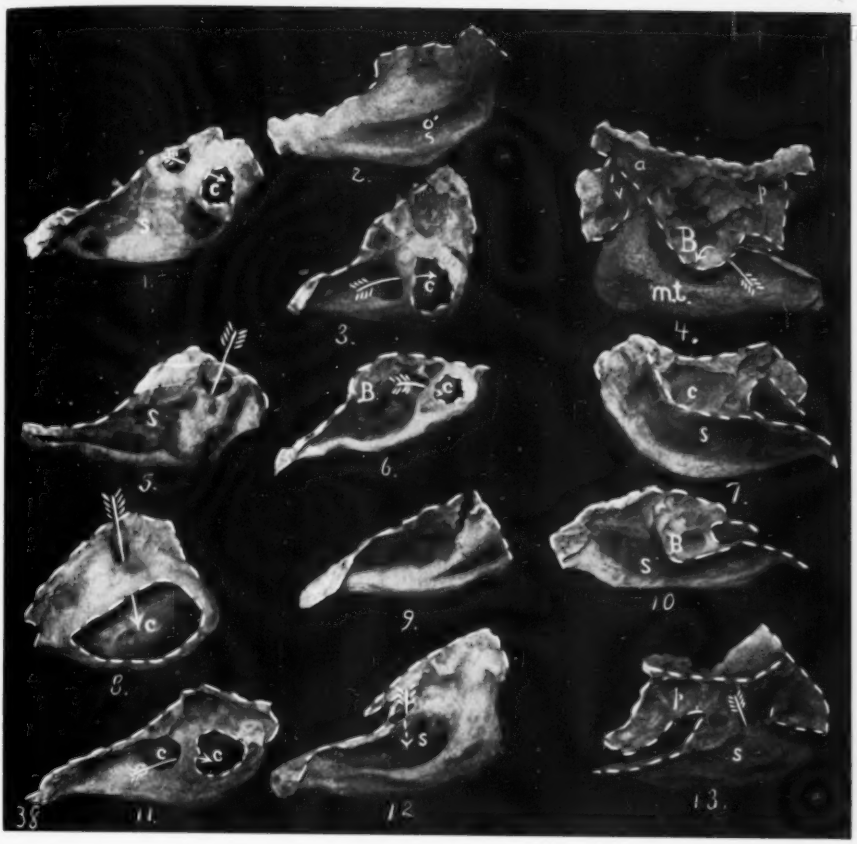
9. Internal wall of left turbinate.

10. External wall of left turbinate. *B*, bulla.

11. External wall of right turbinate containing a cell in anterior third. The *c* to the left is at the ostium of the cell.

12. External wall of right turbinate. The arrow shows a cell placed vertically in the middle third of the turbinate. The turbinate sinus is deep.

13. External wall of right turbinate; arrow enters a large cell in anterior half of turbinate.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nized by a small oval prominence on the internal surface of the turbinate (Figs. 5, 15, 16). The cavity within the fissure seems to be carried down into the cell.

The cells possessing these characteristics resemble closely in every way anterior and posterior ethmoidal cells.

Another variety of small cells is associated with the sinus turbinalis, and these cells are often multiple. It would seem as though small pockets opening into the sinus became deeper and the ostium smaller until a well recognized cell was formed. They are essentially diverticula from the sinus. The mucous membrane makes these cells more pronounced. These smaller cells opening into the sinus are common and have very little clinical importance. They are near the inferior portions of the turbinate, and do not communicate with the anterior ethmoid cells. Examples are seen in Fig. 14, Nos. 3, 5, 6, 11.

The larger cells observed in the inferior ethmoidal turbinate are of fairly common occurrence, and it is to this type that the name "concha bullosa" has been applied. About 5 per cent. of all middle turbinates possess such a cell. It is this condition which is of peculiar surgical importance, and this variety includes most of the clinical cases reported. There is no relation between the size and location of these cells and the location of the ostium.

As a rule, the cell occupies the anterior half of the turbinate, whence it may extend upward or backward according to its size. The turbinate is wide, thus increasing the normal convexity towards the septum nasi, and at the same time encroaching upon the turbinate sinus. The larger cells extend fully to the anterior angle, but sometimes a strip of cancellated bone remains along the inferior and anterior borders (Fig. 9). Frequently these cells extend well towards the posterior angle, and superiorly they may communicate by a large passage with posterior or anterior ethmoid cells, so as to form a large chamber extending to the level of the lamina cribrosa. In many instances these turbinate cells are obviously a part of an ethmoid cell which is situated partly in the lateral mass and the turbinate. Ethmoid cells and frontal sinus may drain

into a middle turbinate cell (Figs. 15, No. 3, and 16, Nos. 4, 6). The cells are oval and flattened laterally.

The size of the cells varies. The following table shows the size and relative variations of the three dimensions of some of the larger cells:

HEIGHT.	LENGTH.	WIDTH.	
Millimetres.	Millimetres.	Millimetres.	
18	11	12	
17	20	7	
20	15	8	
14	18	11	
20	25	8	
8	10	5	
31	25	14	(Fig. 6)
25	15	12	(Fig. 4)
19	29	10	(Fig. 14, No. 8)

Ostia.—Every ethmoid cell without exception possesses an ostium. An occasional clinical case has been reported where it is claimed that the cell possessed no ostium, and the reason for such conclusion is readily understood when the location of the ostium is considered.

Location.—Whenever the cell opens above the middle turbinate bone into what is usually called the superior meatus of the nose, the location of the ostium is constant, irrespective of the size of the cell. It is situated at the extreme anterior end of the inferior ethmoidal turbinate, more or less concealed, when viewed laterally, by the lamina of the superior turbinate (Fig. 6). It is oval and from two to four millimetres in diameter. The ostium of a large cell does not differ much in any respect from that of a small cell. In all instances it is placed at about the highest level of the cavity, and therefore it is most unfavorably placed to facilitate drainage from any cell within the turbinate. All turbinate cells which communicate directly with posterior ethmoid cells open thus. Of all turbinate cells about 45 per cent. open into the inferior ethmoidal fissure, *i.e.*, the region commonly termed the superior meatus.

Middle turbinate cells may open below the turbinate into the middle meatus, and of all cases about 55 per cent. com-

municate thus with the nasal fossa. A few of the smaller cells may open into any portion of the turbinate sinus, but these are usually small diverticula from the sinus and of comparatively slight importance. The ostium of the larger cells occupies a very constant position on the external surface just above the turbinate sinus. It is opposite a point above and anterior to the upper portion of the ethmoid bulla (Figs. 4, 8, 9). In shape it is commonly crescentic with the convexity downward, and may measure from three to ten millimetres in length. Its plane is parallel to that of the turbinate, but the plane of the ostium opening above the turbinate is at right angle to that of the turbinate. This type of ostium is at the upper portion of the cell and offers poor drainage. A somewhat larger percentage of the bullous type of cell opens into the middle meatus. It is the cells opening by this route that communicate with the anterior ethmoid cells, the frontal sinus, and frontal bulla.

If a bullous turbinate is removed by snare or forceps, the line of fracture is below or through the ostium, hence the removed portion may contain a large cell without any apparent ostium.

The disposition of ostia varies when multiple cells are present in the same turbinate. Both cells never open above but both may open below (Fig. 16, No. 1) the turbinate, or there may be an ostium on either side (Figs. 5 and 15, No. 5). When the cells are arranged one in front of the other, the anterior cell generally opens into the middle meatus, the posterior into the superior meatus (Fig. 5). Of thirteen turbinates containing comparatively large double cells, in no instance did both cells open above the turbinate, but in three cases both communicated with the middle meatus, and in ten cases one cell opened above and the other below the turbinate. Occasionally the turbinates of opposite sides contain a cell, both communicating with the nasal fossa by the same or different routes.

The walls of the cells vary in thickness within narrow limits. The lateral walls are usually thinner than the wall of

an ordinary turbinate, and if the cell is of the bullous type and extends fully to the anterior border, the front wall is equally thin. Where the cell is small and occupies the upper portion of the turbinate, the proper lateral walls of the cell are thin, but the remaining portion of the lamella of the turbinate is unchanged. Partitions between cells are thin.

The mucous membrane which lines these cells does not differ from that lining the general cavity in the ethmoid region. It is devoid, however, of the erectile tissue which is characteristic of the internal surface of the turbinate. It consists of ciliated columnar epithelium and basement membrane, together with some loose connective tissue in which are distributed lymph and blood-vessels and glands. The osseous tissue is characteristic of that belonging to the ethmoid bone. As a result of pathological processes, such as catarrhal inflammation, hypertrophy, polyps, and atrophy, the appearance of the mucous membrane may be profoundly altered.

Relation of Cells to Surrounding Structures.—Internal to the cells is the septum nasi (Figs. 9 and 13), and, according to the size of the cell and the angle of the turbinate and the curvature of the septum, the cell wall may be in contact with the septum. Adhesions are rare.

External to the cell we have the bulla and uncinate process, together with the important ostia in the vicinity. A cell of any considerable width is apt to obstruct these ostia, giving rise to symptoms according to the ostium involved. There is no structure immediately in front of the cell, but posteriorly there is often a portion of the bulla, if prominent, and the accentuated concavity of the turbinate sinus (Fig. 14).

Recognition of the Presence of Middle Turbinate Cells.—The vicinity of the anterior angle of the middle turbinate is practically always in view when examined from the anterior nares. An unusual width of this region may be due to a deviation or undue curling of the turbinate or to the presence of a cell. The bullous type can be seen filling up the apertura pyriformis, and perhaps obstructing the olfactory fissure, or even extending from the septum to the bulla. Only in exceptional

FIG. 15.—Internal surface of a series of turbinate bones which contains a cell (*c*). The internal wall of the cell has been partly removed, as shown by a dotted line. The horizontal line marks the roof of fossa. *c.g.*, crista galli; *s.t.*, superior turbinate; *m.t.*, middle turbinate; *f.e.i.*, inferior ethmoidal fissure; *S*, sphenoidal sinus with arrow through its ostium.

1. *c*, cell, into which an arrow passes through a wide ostium from the middle meatus; *U*, uncinate process; *B*, bulla ethmoidalis; arrow passes between bulla and uncinate process to antrum. A long arrow passes from the frontal sinus to the middle meatus.

2. A large bullous cell, with arrow from middle meatus occupying the anterior half of turbinate. It measures twenty-three millimetres long, twenty-six millimetres high, and twelve millimetres wide. A posterior ethmoid cell (*p*) opens into the ethmoid fissure as indicated by arrow.

3. Small cell opening into the ethmoid fissure.

4. A large cell in the anterior third of turbinate, which communicates with middle meatus by a long semilunar ostium (arrow) and extends above it into an anterior ethmoid cell. *a.o.m.*, accessory ostium maxillare; 1 and 2, two superior turbinates. Turbinate cell measures fifteen millimetres long, twenty millimetres high, and nine millimetres wide.

5. A turbinate containing two distinct cells; the anterior one communicates with the middle meatus, the posterior with the ethmoid fissure, as shown by arrows.

6. A very large cell which is continuous with posterior ethmoid cell and opens into ethmoid fissure. *a.o.m.*, accessory ostium maxillare. It measures twenty-two millimetres long, thirty millimetres high, and nine millimetres wide.

1.
c.g.
st.
fei
B
c
m.t.
2.
c.g.
p
st.
f.e.i.
c
m.t.
3.
S.
c.g.
fei
c
m.t.
4.
c.g.
fei
m.t.
c
com
a.o.m.
5.
c.g.
S
p
fei
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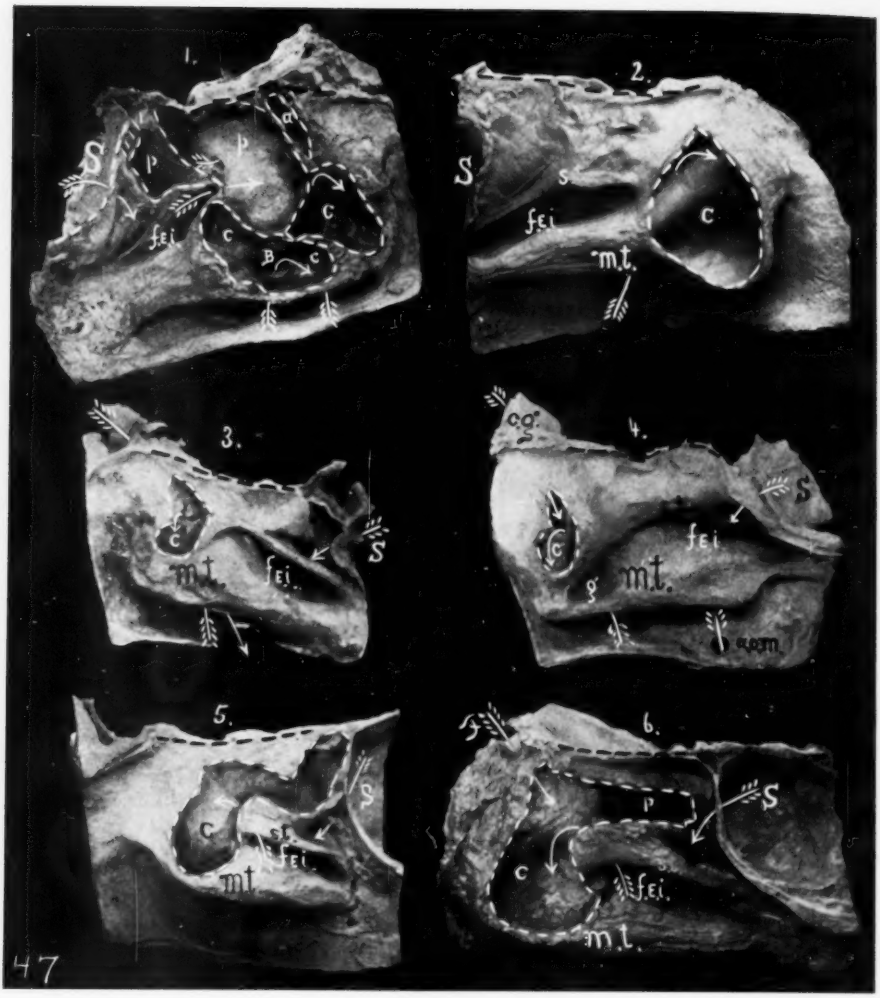

FIG. 16.—Internal surface of a series of turbinates which contain a cell (*c*), the wall of which has been removed and marked with a dotted line. Horizontal line corresponds to roof of nasal fossa. *S*, sphenoidal sinus, with arrow indicating ostium; *s.t.*, superior turbinate; *m.t.*, middle turbinate; *f.e.i.*, fissura ethmoidalis inferior; *a*, and *p*, anterior and posterior ethmoid cells.

1. Section passes through two cells in the turbinate and also some ethmoid cells; both turbinate cells open into the middle meatus.

2. Large cell measuring eighteen millimetres long, twenty-one millimetres high, and ten millimetres wide.

3. Small cell in upper portion of turbinate.

4. Small cell opening into middle meatus; posteriorly is a short, deep groove. An arrow passes from frontal sinus to the turbinate fossa; an arrow enters the antrum through the accessory ostium.

5. A large cell continuous with a posterior cell, both of which open into the ethmoid fissure by a common ostium. It measures twenty-two millimetres long, thirty-two millimetres high, and ten millimetres wide.

6. A large cell similar to 5, measuring thirty-three millimetres long, twenty-one millimetres high, and eleven millimetres wide.

instances could the presence of a cell be detected by posterior rhinoscopy (Fig. 10). The location of the ostium could not be determined in a normal cell.

Origin of Cells in the Inferior Ethmoidal Turbinate.—Embryology shows that at birth there are no cells associated with the ethmoid bone (Fig. 7); that at four to five years cells begin to develop by the pushing in of pockets lined with mucous membrane; that at puberty the ethmoid cells are fully developed; that the cells do not change materially in health, but that in the aged they may become a little larger in consequence of atrophy of their walls. The inferior ethmoidal turbinate or "middle turbinate" is a portion of the ethmoid bone, and its development depends upon that of the rest of the bone.

Anatomical research of a large number of normal middle turbinates reveals the following facts: That in about 9 per cent. of all turbinates examined bony cells were present; that these cells frequently communicated with either anterior or posterior ethmoid cells, and were occasionally multiple; that the cell could lie partly in the lateral mass and partly in the turbinate; that the structure and appearance of the cells resemble those of ethmoid cells; that the cells very rarely showed the presence of any pathological process; that all these cells have ostia; that frequently the superior turbinate consisted of a narrow lamella or a sharp ridge on a posterior ethmoid cell. No closed bone cavities or bone cysts were discovered in any of the turbinate bones.

There are two theories among clinicians as to the formation of cavities or cells in the inferior ethmoidal turbinate:

(1) That these are closed osseous cystic cavities produced by an inflammatory process giving rise to an exaggerated curling of the bony lamella until it has formed a bony cavity or osseous cyst. In these instances there is claimed to be an absence of lining mucous membrane and a particular arrangement of osteoclasts and osteoblasts.

(2) That these cells already exist in the turbinate as normal structures, and may be the site of subsequent inflammation with consequent pathological changes.

The following conclusions are drawn as regards the occurrence of these turbinate cells, based chiefly on anatomical investigation:

That the presence of turbinate cells in 9 per cent. of all cases is not a pathological condition; that these cells are normal in every respect; that they are usually not large, but that even the largest cells do not differ from the anterior and posterior ethmoid cells, and develop in the same way and are really ethmoid cells; that the presence of most of the cells could not give rise to any symptoms, but that even without any pathological changes the cell may become large enough to cause obstruction to respiration, to interfere with the sense of smell, and to give rise to reflex symptoms in consequence of pressure; that as a result of inflammation secondary changes may take place in the mucous lining and also in the bony wall of the cell, whereby its general character and size may be altered, particularly when the ostium becomes closed; that cells of considerable size must exist without their presence being known until the patient seeks relief for nasal obstruction, when a cell may be discovered complicating an acute catarrhal process which was just enough to make complete an already partial obstruction; that in cases of empyema of such a cell where the ostium remains closed, we have practically an abscess cavity, the walls of which are capable of great distention.

THE CLINICAL HISTORY OF MIDDLE TURBINATE CELLS.

The salient clinical features of these cases will be reviewed briefly, based upon the reported cases and a recent well-marked example occurring in the practice of the writer.

Occurrence.—There are about thirty authentic cases on record. All cases occurred practically in adults, the youngest patient being sixteen years old. Although about three-fourths occurred in females, there is no reason why one sex should be prone to the condition. More than half the cells contained air and the walls were not the seat of any pathological process. There were five well-marked examples of empyema of the cell,

while other cases were complicated by the presence of hypertrophied tissue and polypi within the cavity. They were about equally distributed on either side, and in two instances both middle turbinates were involved.

Symptoms.—In all probability most turbinate cells give rise to no symptoms. They are subject to the same changes undergone by other ethmoid cells in health and disease.

There are two general groups of symptoms which may be caused by middle turbinate cells,—one due to the size of the cell, the other due to the presence of inflammation. Both factors may be present simultaneously. The cell may be of sufficient *size* to cause the following symptoms:

There may be complete or partial obstruction to respiration, generally unilateral, which persists irrespective of the presence or absence of a rhinitis. This gives a sense of pressure. Mouth breathing may be necessary.

Pain is often referred to one side of the face and is of a neuralgic character. This may be distributed along any of the branches of the trifacial nerve, manifested as pain along the supra-orbital nerve, about the eye, or in the teeth of the superior maxilla.

There may be a nasal quality to the voice.

The sense of smell may be interfered with.

There may be headache and occasionally dyspnœa on exertion.

Reflex nervous symptoms have been reported as due to the pressure of the turbinate on neighboring structures.

No authentic reports of external nasal deformity due simply to an enlarged turbinate cell are on record. Such enlargement may cause a deviation of the septum and distort the structures external to the cell, causing secondary symptoms in the antrum and frontal sinus. Photophobia, epiphora, and exophthalmos are said to accompany the condition.

In general, it may be said that a non-inflamed turbinate cell causes no symptoms, but that otherwise the chief complaint is that of unilateral nasal obstruction with a sense of fulness and some pain in the nose.

Whenever such a cell becomes inflamed the character of the symptoms changes. Until the onset of these symptoms there may have never been any trouble caused by the cell. The symptoms due to inflammation may supervene on those already existing in consequence of pressure. The symptoms of acute rhinitis with obstinate nasal obstruction commonly cause the patient to seek medical advice, when the true condition may be observed for the first time. The obstruction may remain obstinate, and if the ostium is occluded, an empyema of the cell follows because the retained contents of the cell become infected. The usual changes due to suppuration in mucous membranes follow, until eventually the cell ruptures with or without bony rarefaction and cell enlargement. The persistence of hypertrophy and polypoid degeneration favor the obstruction and suppurative process, and the nasal discharge persists. Crusts collect and there may be odor. A suppurative process well established in such a cell is apt to become chronic because of the unfavorable location of the ostium for drainage.

Diagnosis.—It is usually difficult to diagnose the presence of a small middle turbinate cell which is not the source of any discomfort. If the cell is in the upper portion of the turbinate, its presence cannot be established. Only the bullous type of cell can be determined with any degree of satisfaction. Through the anterior nares, a tumor presents in the apertura pyriformis, with rounded outline and occupying the position of the inferior ethmoidal turbinate ("middle turbinate"). A small probe can be made to pass between it and the nasal septum and externally between the tumor and the outer nasal wall. It is immovable and hard, although its covering mucous membrane may be hypertrophied. The wall may be thin and bend under the pressure of the probe. The diagnosis is confirmed if a probe or other instrument breaks through the wall and enters a cell cavity. Pus may be made to escape from an opening made in the cell in cases of empyema. In a case of empyema of the bullous type of cell, operated recently by the writer, the cell wall was thin and very membranous. In this instance, pressure on the cell with a probe caused an excess

of pus to escape from well above the turbinate, showing that the ostium was situated at the inferior ethmoidal fissure. The diagnosis of the presence of multiple cells would be very difficult.

A differential diagnosis should include the following conditions, which will be simply enumerated: Polypi. Hypertrophy of mucous membrane. An abnormally prominent ethmoid bulla or other ethmoid cell. Cysts of the mucous membrane of the turbinate. Abnormally broad curvature of the turbinate. Malignant tumor. Osteoma of turbinate. Cell of turbinate.

Treatment.—The treatment of any condition due to the presence of a cell in the inferior ethmoidal turbinate presents no difficulties and offers the hope of permanent relief. The part can be thoroughly anæsthetized by means of cocaine, and the hæmorrhage carefully controlled during operation by means of a solution of adrenalin chloride.

The cell may be removed by means of the snare or any cutting instrument. It is probably wise to remove all of the cell. This can be done at one time with the snare, provided the cell is small; but if the cell is very large, a portion of it usually remains behind. This may be removed subsequently with cutting forceps, or, if it does not press on the structures laterally, it may be left after the interior has been carefully curetted.

THE GRADUAL SURGICAL OCCLUSION OF LARGE ARTERIES: ITS RELATIVE ADVANTAGES, TOGETHER WITH AN EXPERIMENTAL INQUIRY AS TO ITS FEASIBILITY.[1]

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MURPHY'S demonstration of the possibility of restoring the lumen of resected arteries by circular arteriorrhaphy, Crile's and Keen's reports of successful temporary closure of large arteries, Matas's apparently radical cure of aneurism by suture and infolding of the sac, and the work of other investigators and clinicians in our own and other countries have called the attention of the profession to the fact that the chapter on the surgical technique in relation to the larger blood-vessels is not closed, and form the reasonable basis of a hope that much more will yet be accomplished in that field of surgery.

The dangerous results which attend the ligation of the largest arteries call for improvement, if possible, in our methods. At least, such unfortunate sequelæ of ligation as are due to the suddenness with which that procedure is now practised would seem to be within the range of prevention. While it is true that in a large proportion of individuals abrupt surgical closure of large arteries is unattended with alarming symptoms, yet in other patients the same procedure causes, immediately or remotely, grave dangers. This is especially true if the heart of the patient is weak, or his blood-vessels are wanting in the usual elasticity, or if for any reason his vital force is impaired. In case of ligation of the innominate or common carotids, experience teaches us that we may fear convulsions or paralysis, mental disorder or immediately fatal

[1] Read before the Medical Society of the State of California, April, 1903.

cardiac palpitation and dyspnœa; in the case of the abdominal aorta, paralysis or mortification of the lower extremities, prolonged and severe pain, extreme shock and dangerous or fatal effects upon the heart. In case of ligation of other large arteries, but those less closely associated with vital organs and processes—the iliac, femoral, subclavian—gangrene may be feared. Failure of the establishment of the collateral circulation will also best account for some of the deaths from cerebral disease following ligation of the carotids. These effects are in large part, if not entirely, due to the suddenness of the arterial closure, certain areas being abruptly deprived of their accustomed blood supply, or to the damming back of the blood, resulting in an excessive amount being thrown upon the heart, the brain, and probably the lungs. Keen's case of ligation of the abdominal aorta very vividly portrays some of the dangers and results of abrupt closure. At the moment the ligature was applied, the pulse rose from 90 to 130, and the patient's head, face, and neck became deeply congested and almost livid.

Pathology can teach us valuable lessons in this regard. A limb suddenly deprived of its arterial blood supply is more apt to become gangrenous than when the deprivation is gradual. Furthermore, the complete closure of large arteries by the very gradually increasing pressure of growing tumors is unaccompanied by symptoms due to such occlusion, the collateral circulation being slowly and completely perfected and without reflux congestive disturbances. The more nearly the surgeon approximates the method of nature in this respect the more successful will be his efforts to accomplish his purpose. It will certainly be a decided step ahead, if, in addition to securing closure without the immediately dangerous effects upon the vital organs due to the abruptness of our present ligations, a method can be discovered which will better facilitate the establishment of the collateral circulation. Furthermore, if the method will determine the impossibility of accomplishing that, at a time when the caliber of the vessel can be safely restored and the method abandoned without material risk, the advance will be more marked.

It is a question yet to be clinically decided whether the collateral circulation in case of surgical closure would be more surely established if the arterial occlusion were gradually accomplished than it is by the present abrupt method. But the experience that pathology presents that arterial closure by tumor growth does not cause gangrene, and that even in diffuse arteriosclerosis the degenerative process may not involve all the arterioles, and at any rate in these smaller vessels may exist in less advanced form, would tend to show that failure of the collateral circulation in our operative work was in large part due to the suddenness of the method. Moreover, it seems reasonable that if the vitality of distal parts can be merely sustained by partial arterial patency while even arterioles with lessened elasticity have, under prolonged increased intravascular pressure, had an opportunity to enlarge, that they will, in most cases, ultimately do so to such a degree as to permit the still further, even the complete, closure of the artery.

My first experiment undertaken to test the practicability of gradual occlusion consisted in an attempt to apply a clamp to the abdominal aorta of a dog. The result made me feel that some other method by which the pressure around the artery could be more delicately adjusted and which would permit an easier and safer removal of the apparatus was highly desirable. Subsequent to this, Keen undertook to prove the feasibility of direct temporary complete compression of the abdominal aorta by means of a clamp, and, for this purpose, he operated upon a number of dogs, and showed that it was possible to do so in that animal with comparative safety. It does not appear, however, from the reading of the report of his experiments (*American Journal of Medical Sciences*, September, 1900) that the idea of gradual occlusion of that or other arteries was contemplated by him. The closest approach to anything in the line of gradual surgical occlusion of blood-vessels of which I can learn was undertaken by Milton in 1890 (*Lancet*, 1891, Vol. i, p. 85), when, in considering operative procedures in relation to the cure of aneurism of the abdominal aorta, he devised a plan to apply direct pressure to the vessel by means

of a rubber tube passed through the lumbar muscles and around the spine and aorta. His idea was not, however, put to a practical test. His plan was to "compress the aorta against the vertebral column by traction on the two ends of the drainage tube. The amount of pressure to be applied and the period of its application were to be regulated by the effect produced on the patient." It does not appear, however, that gradual progressive occlusion was distinctly conceived or intended, or that, as a general surgical principle, it was clearly recognized or suggested as applicable to other vessels.

From the numerous different procedures proposed and instruments invented for the purpose of effecting direct or indirect, partial or complete temporary compression of large arteries for the cure of aneurism, notwithstanding my inability with considerable searching to discern its distinct conception, it is hardly likely that the closely related principle of gradual occlusion was not apprehended. But whether this be true or not, there certainly remains room at this time for its clear and emphatic pronouncement and the suggestion, if possible, of such a feasible technique that it may be accorded general professional recognition.

In my subsequent experiments along this line I endeavored to test the practicability of gradual occlusion with an instrument operating upon the principle of the écraseur. This would permit, I thought, of a very delicate adjustment of the degree of constriction of the artery, it would not be easily displaced, and would be quite readily removable. The abdominal aorta of medium-sized female dogs was selected for these trials.

EXPERIMENT 2.—Arterial closure effected by means of largest size iron-dyed silk ligature passed around artery and through a slender, gauze-covered, German silver cylinder, with a circular, perforated disk the size of a dime attached transversely to the extremity to be placed in contact with the blood-vessel. The ligature was fixed at its outer extremity by means of a slender, cone-shaped, wooden plug pressed into the aperture of the constrictor, thus binding the ligature at any desired degree of tension upon the artery.

May 20, 9.30 A.M. Ligature applied to aorta about one inch above bifurcation, the size of the artery approximating closely to that of the

carotid in man. Abdomen closed around the instrument and dog encased in plaster of Paris. Ligature then tightened until a pronounced effect was produced upon the femoral pulse and fixed at that point, after testing the working of the instrument and noting that the pulse could be perfectly controlled by relaxing or increasing the tension of the ligature.

2 P.M. No paralysis of the posterior extremities exists, although the hind legs are cooler than the front.

May 21, 9.30 A.M. Constrictor tightened so as to make a just perceptible femoral pulse. Dog apparently strong and not suffering.

2 P.M. Dog has struggled out of cast and the ligator subjected to great violence. Wound uncovered, and a knuckle of intestine protruding from abdominal cavity is cold and covered with dirt. Intestine cleansed and replaced with difficulty. Forcible femoral pulse noticed. The ligator firmly tightened so as to entirely abolish the femoral pulse.

10 P.M. No pulse yet perceptible. Ligator relaxed and quite a full pulse returns. Tightened to a point allowing a just perceptible pulse and fixed there. Thighs have remained warm.

May 22, 5 A.M. No femoral pulse.

11 A.M. No pulse has returned, although the thighs are quite warm. No paralysis exists. Abdomen opened. Intestines and omentum matted around ligator and adherent to the abdominal wall. Mass of inflammatory exudate around artery at the point of ligation. Ligature removed. Aorta ligated about one inch higher on account of severe hæmorrhage attending a different experiment at arterial closure. Abdomen sutured and dog allowed freedom. Continued in poor general condition, apparently weak and exhausted, refusing food and vomiting. No femoral pulse felt at any time, but thighs warm and not paralyzed.

Dog killed at 11 A.M., May 26, the sixth day from the original operation. The cause of the dog's failure was found to be necrosis of a knuckle of intestine. Mesentery adjacent to bowel also necrotic. Deeper parts of mesentery healthy, showing condition not the result of aortic ligation, but rather the result of traumatism and exposure incident to dog's struggles. The site of the application of the gradual ligator was carefully examined. A mere suggestion of thinning of the arterial wall was discernible, notwithstanding the extreme violence to which the constrictor had been subjected, and that only a heavy silk ligature was used. Its location could only be recognized on careful examination by slight ecchymosis of the adventitia and redness of the arterial tunics on longitudinal incision, together with a very slight, superficial roughening of the intima in three small areas. In this experiment the constrictor was applied to the artery for fifty hours, twenty-nine hours elapsing before the lumen of the vessel was occluded.

EXPERIMENT 3.—In this and the following trials, a cotton tape one-fourth of an inch wide was passed around the aorta and through a gauze-covered, sterling silver, hollow shaft of light weight, both ends of the tape being fastened to the axle of a small windlass fixed to the instrument at its outer extremity. The revolving of this tightened or relaxed the tape at the will of the operator, while the wheel could be fixed at any point by

means of a hinged bar being pressed into small slots in the margin of the wheel. The shape of the extremity of the instrument to be placed adjacent to the artery was so formed as to permit a slight rolling outward of the margin of the tape in contact with the artery. The object of this was to avoid, if possible, traumatism of the arterial wall by the pulsation of the aorta against a tense tape margin.

Operation, June 3, 10 A.M. Tape applied loosely to the abdominal aorta about two and a half inches above bifurcation.

11 A.M. The tape tightened until there was a perceptible effect upon the femoral pulse, the working of the instrument having been previously tested, and it was noted that the pulse could be caused to disappear or return at will.

2 P.M. Tape tightened slightly.

11 P.M. Femoral pulse detected.

1 A.M. Dog alive. No paralysis noted at any time.

June 4, 8 A.M. Dog found dead, apparently from strangulation due to the inspiration of vomitus, the result of the fixed position of dog in cast.

Autopsy.—One-half or less of the caliber of the aorta was found to be occluded by the tape. Removal of latter required considerable force on account of its close adhesion to the artery. Ecchymosis of the arterial wall locally at the site of the ligator. Vitality of the arterial wall apparently good. Intima found lacerated superficially in short transverse lines at site of tape, as if from stretching upon its withdrawal. No other lesion was discernible. In this case the constrictor was applied so as to partially occlude the aorta for about fifteen hours.

EXPERIMENT 4.—September 4, 12 M. Applied tape constrictor about one inch above the bifurcation of the aorta, the tape being infiltrated with paraffin with a view of preventing its adhesion to the artery, thereby facilitating its removal. Instrument controlled perfectly the flow of blood through the artery. Before operation closed, the ligator was tightened so as to reduce about one-half the volume of blood passing through the aorta. After operation, when anæsthesia had passed off, there was no paralysis of the hind legs.

4 P.M. Tape slightly tightened so as to further reduce femoral pulse. Dog resting easily and in good condition.

9 P.M. Ligator still further tightened.

September 5, 8 A.M. Femoral pulse apparently stronger than at last examination. Tape tightened and pulse reduced. General condition good, not suffering; takes food voluntarily. Hind legs warm; no paralysis.

4 P.M. Constrictor tightened, so that the femoral pulse is just perceptible. A slight turn of the wheel entirely shuts off the pulse.

7 P.M. Femoral pulse not perceptible.

11 P.M. Femoral pulse absent. Constrictor tightened to the full extent. Artery, although not pulsating, less plainly felt thereafter. Legs warm.

September 6, 9 A.M. No femoral pulse. General condition very good. No paralysis. Tape loosened and femoral pulse felt rather feebly.

10.30 A.M. Dog examined under anæsthesia. Ligature had been applied forty-seven hours, during about thirty hours of which time the lumen of the vessel was partially occluded. Wound in excellent condition; no sepsis. Omentum and intestines matted to the abdominal wall and to each other around the instrument, the ligator being completely walled off from the peritoneal cavity. Pulsation felt in the abdominal aorta below tape. The instrument was removed and the tape withdrawn by traction on one end, no undue force being required. Arterial wall at site of tape constrictor is firm, thickened, and ecchymotic. Dog killed with chloroform and artery removed. Small recent clot found in artery at site of tape.

Microscopic examination was kindly made by Dr. C. W. Dodge, who reported all three coats of the artery at the site of the occlusion intact.

In this case much difficulty was met with in the removal of the instrument by reason of the close adhesion of its gauze envelope to the intestines. The tape, however, was readily removable.

EXPERIMENT 5.—Paraffined tape constrictor applied one inch above bifurcation, partly closing lumen of aorta; in place forty-four hours. Progressive constriction carried on at intervals during forty-three hours before closure effected. No paralysis. Instrument and gauze withdrawn with ease; tape required more, but not undue force. Dog killed fourteen hours after removal of tape.

In this experiment, gauze was arranged in spiral form loosely around ligator after the latter was in place. Application of cast after completion of operation caused marked change in angle of ligator with artery, together with a partial twist of its transverse axis. Rectification not accomplished, as it was impossible without reopening the abdomen.

Autopsy.—Fairly good walling off of site of constrictor from general peritoneal cavity. Localized infection of peritoneum beneath abdominal incision, apparently extending down to artery. Ecchymosis and constriction of artery show location of tape.

Microscopic report, kindly rendered by Dr. C. H. Rowe, is of special interest as showing probable combined effect of infection and unequal pressure upon artery by disarrangement of instrument, above referred to. It should be remembered, however, that both of these would be almost entirely eliminated in operating in man.

"Outer two-thirds of adventitia destroyed over one-fourth the circumference of artery. Beneath this area the muscularis is infiltrated with leucocytes, and nuclei of muscle cells stain poorly. Internal elastic coat nearly destroyed throughout same extent of vessel, but intima not changed. All other parts of artery are normal."

It is considerable of an indication of the relative advantage of this method over ordinary ligation that unfavorable symptoms, due to the act of closure, were not discernible, and it is especially significant that complete paralysis of the posterior

extremities was not noted at any time, although Keen concludes from his experiments, which were performed four times, that "in dogs (temporary) paralysis of the hind legs follows complete obliteration of the aortic stream." These experiments are sufficient to demonstrate the fact that, at least in dogs, a large artery can be gradually constricted without undue violence to its walls. It will be impossible to approximate in lower animals the exact conditions which exist in man when the largest or atheromatous arteries are subjected to operation. However, I have in mind further investigation to note the effect of gradual and partial occlusion carried on for a period of several days longer than in the above tests. This would approximate better the procedure which might be found desirable where difficulty is met with in obtaining the establishment of the collateral circulation. Certain changes in the form of instrument also are suggested, tending to better avoid traumatism of the arterial tunics. I have, however, deemed it advisable to incorporate this preliminary report as presenting sufficiently valuable lessons.

If continued experience shall prove the feasibility of gradual occlusion, aside from its limited value in selected cases, as a preliminary to permanent ligation in the extirpation of tumors or in other operative procedures requiring complete closure or resection of large arteries, it would seem to have its most pronounced opportunity for usefulness in the relief of aneurism, through its control of the blood current. For it should be remembered that the natural and surgical cure of that disease is best brought about, not by such conditions as induce sudden clotting en masse, but rather by the gradual deposition of the coagulum within the sac. It is not suggested, however, as applicable to all cases or to displace the rightful use of present recognized methods. In few other surgical diseases are so many different procedures essential to meet the actual necessities of the individual patient, and gradual closure, as an additional resource, would seem, in a minor proportion of cases at least, to better meet existing indications than other methods. However, its relation to the cure of aneurism, together with

the various modifications of technique indicated in that disease, must meet with later consideration.

It might be well to add that two things should govern the application of gradual occlusion: the artery and the condition of the heart and blood-vessels. Thus it would seem to be indicated in all patients requiring closure of the abdominal aorta,—not in this case, however, in conjunction with permanent ligation, inasmuch as the latter procedure, in man, by any means yet devised, is almost necessarily fatal. In the case of arteries of lesser caliber, except for special reasons which might determine its use for aneurism, the forcible or weak blood current, together with the presence or absence of arteriosclerosis and the accompanying lack of general tissue-vigor, would determine the desirability of adopting gradual closure or ordinary ligation.

THE TREATMENT OF THE PERITONEUM IN DIFFUSE PERITONITIS.[1]

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FROM the stand-point of therapy, the classification of the purulent forms of peritonitis by the specific nature of the bacterial invasion is not of so much importance as that based upon the progress and extent of peritoneal involvement. Therefore, it has been my custom to classify these cases in the following groups: 1. Cases with abscess, in which there is a localized collection of pus with limiting adhesions. 2. Cases with spreading peritonitis, in which there is no limitation of the process by adhesions or gravitation, but in which the limits are ascertainable. 3. Cases of general peritonitis, in which no parts of the peritoneum, possibly excepting the lesser sac, can be demonstrated as free from the invasion. The last two groups are comprised under the general term, diffuse peritonitis.

In my report of cases I have held rigidly to this classification, and I have included in my cases of spreading peritonitis cases which would ordinarily be considered to be cases of general peritonitis. I have also excluded a number of cases which recovered and in which the process was spreading, but was not extensive. In other words, the cases of spreading peritonitis here presented would, in so far as I can judge from my experience, all have become generalized in a few hours, and further all presented the symptoms of a generalized peritonitis before operation. I particularly emphasize this point since these cases are of especial interest in regard to certain questions of treatment. All the cases have been operated upon by myself and comprise all the cases of general and spreading peritonitis

[1] Read before the American Surgical Association, May 12, 1903.

arising from all causes that I have met with in the last two and one-half years, excepting those occurring in connection with new growths and intestinal obstruction where the primary disease overshadowed the secondary peritonitis.

In three actually moribund cases—one from appendicitis and two from the perforation of typhoid ulcers—I have refused to operate, and these cases died within a few hours of the time I first saw them; but, on the other hand, I have been led to operate upon a number of moribund cases by the recovery of some cases that seemed positively hopeless.

It is not my aim to advance anything new in the treatment of these cases or to claim anything unusual in the way of results, but to simply report the cases and give the reasons that have led me to the treatment I now employ. I have chosen the cases occurring in my practice during the last two years and a half, since they have been operated upon under practically the same conditions, and therefore are better for comparison.

The cases have been tabulated and are appended. They comprise seventeen cases of spreading and fifteen cases of general peritonitis. Of the cases of spreading peritonitis, ten were caused by appendicitis, of which ten recovered and none died; one by perforating typhoid ulcer, no recovery, one death; four by perforating ulcer of the stomach or duodenum, of which two recovered and two died, a mortality of 50 per cent. The deaths were both attributable to sepsis from the local condition; two from gonorrhœal infection, both recovering from the peritonitis, but one dying later on the thirty-fifth day after operation from an obscure pyæmia. Of the cases of general peritonitis, seven were caused by appendicitis, of which three recovered and four died, a mortality of 57 per cent.; one by perforating typhoid ulcers, one recovery, no death; one by perforating tubercular ulcer, no recovery, one death; six by infection through the Fallopian tubes, one of which was probably a pneumococcus infection, one a mixed streptococcus and gonococcus infection, and the remainder gonorrhœal, of which one recovered and five died, a mortality of 83 per cent.

The latter six cases with the two cases of spreading gonor-

rhœal peritonitis form a rather remarkable series of eight cases of tubal infection and deserve a more extended description than I can afford them in this paper. I regret exceedingly that an absolute bacteriological diagnosis was only made in four of them; in three of the remainder I was led to believe that the infection was gonorrhœal from the clinical evidence. The high mortality was due largely to a condition of extreme sepsis; in one case death occurred from a postoperative volvulus apparently induced by a congenital anomaly of the large intestine.

In the treatment of these cases I have endeavored to carry out two principles: firstly, the removal or segregation as quickly as possible of the cause or nidus in order to prevent further peritoneal and systemic infection; secondly, the placing of the peritoneum under the best possible conditions to withstand and eliminate the generalized infection.

In regard to the propriety of the first principle, which in other words is early operation, I think there is no question, possibly excepting the cases of peritonitis arising from appendicitis.

I myself cannot see the difference between a case of extensively spreading peritonitis caused by infection from the appendix and one arising from any other cause, and further, I cannot believe that such an extensive peritonitis can be localized or arrested by any form of treatment other than operation.

I operate on these cases as soon as they can be prepared, believing that with the cause and the major portion of the toxic effusion removed the peritoneum is placed in a much better position to eliminate and destroy the remaining infection.

I think that any of the advocates of the treatment by rest will concede that the patient would be much better off with the appendix out, if that could be done without operation.

We have then simply to weigh the dangers of the additional toxæmia of the anæsthetic and the shock of operation against the danger of continued infection, both systemic and peritoneal, from the appendix itself or the escape of its contents.

With a short anæsthesia and a quick operation the danger of interference is much less than that of procrastination. There

need be no fear of spreading infection, since that has been already accomplished. We have not so much the peritoneum to fear as we have the systemic infection through the lymphatics and vessels of the meso-appendix. Furthermore, I believe that an inflamed peritoneum is far better able to withstand an augmentation of the infection than a healthy peritoneum the scattered contents of a quiescent abscess. The proper time for the rest treatment in these cases is after the appendix is out and the peritoneum cleansed. I think the cases of spreading peritonitis caused by appendicitis which I report support my contention. These were all cases of extensive spreading peritonitis, ten in number, and all recovered. If we add the cases of general peritonitis in which the whole of the greater sac was demonstrated to be involved, seven in number, the total is seventeen cases operated upon with four deaths, a mortality of 23.5 per cent. Adding one moribund case dying without operation, the total mortality is 27.7 per cent.

The second principle involved in the treatment, namely, the placing of the peritoneum under the best possible conditions to withstand and eliminate the generalized infection, involves two main questions, namely, the cleansing of the peritoneum and the employment of drainage.

In regard to the cleansing of the peritoneum, I have consistently done it, employing for this purpose large quantities of decinormal saline solution at a temperature of 110° F., and consequently have nothing to say about the results obtained by not cleansing or by cleansing by other methods.

I have introduced the solution with a very large glass tube or have poured it in with a pitcher. In most instances I have partially dried the peritoneum afterwards with sponges or large rolls of gauze, or, on the other hand, have left considerable quantities of the solution in the cavity without apparent difference in the results. I am inclined to the latter procedure, since unnecessary handling of the intestines and prolongation of the operation are thereby avoided. My reasons for preferring washing are: that it can be carried out through a relatively small incision; that the peritoneal endothelium is less injured,

and that the toxins are more readily diluted and removed. All loose fragments of fibrin are sluiced out, but the adherent portions are left.

In considering the questions of drainage the cases are best divided into groups, one including those in which the focal cause or origin can be removed or eliminated, the other the remaining cases.

To the first group would be assigned most peritonitis arising from perforation of the hollow viscera, from appendicitis, salpingitis, and possibly cholecystitis; to the second those resulting from rupture of abscesses, from pancreatitis, and cholecystitis in which cholecystectomy was contraindicated.

In the first group drainage may or may not be employed; in the second it is, as a rule, necessary.

I was formerly a warm advocate of abundant drainage; later I became convinced of the utter impossibility of draining every part of the peritoneal cavity, for it was evident that the drains were soon isolated by adhesions; so I next confined myself to the drainage of the field of operation, and then perceiving that the other similarly affected regions of the peritoneum took care of themselves, I have lately omitted drainage almost entirely, and only employed it when the presence of necrotic tissues or hæmorrhage has demanded it.

A comparison between the cases in which drainage was employed and those in which it was omitted is of interest in regard to the occurrence of complications and the duration of convalescence.

One of the principal advantages that non-drainage has over drainage is the avoidance of intestinal obstruction. Intestinal obstruction may be caused by the direct pressure of the drain on the intestine or by the production of adhesions about the site of the drain. Adhesions no doubt occur when no drains are used, but they are undoubtedly increased by their presence.

The only case in this series in which obstruction occurred which could be directly attributed to the drainage was Case 3, of spreading peritonitis following appendicitis. In this case a glass tube was used, passing to the pelvis, and the incessant

vomiting and distention from which the patient suffered disappeared immediately on removal of the tube. Although this is the only accident of this kind appearing in this series, I have observed it several times in other cases. It has, however, seemed to me that there has been much less postoperative meteorism and vomiting in the cases not drained than has been the usual experience when drainage has been employed.

A not infrequently observed complication has been the formation of localized collections of pus in various parts of the peritoneum during convalescence.

This is apparently due to the inability of the vital forces to overcome the entire infection, and consequently more or less isolated patches of unresolved inflammation are left behind.

These collections do not always occur in the natural pockets or fossæ of the cavity, and so cannot be entirely explained by gravitation of the exudate. For the same reason they cannot be prevented by drainage as usually employed. These abscesses were observed in four cases, twice in drained and twice in undrained cases. In one drained case (13), a case of spreading peritonitis due to gastric ulcer, a subphrenic abscess developed from direct extension from the area of drainage in front of the stomach. Probably the aspirating movements of the diaphragm were much to blame for this. In the other drained case, a case of general peritonitis due to appendicitis, a pelvic abscess was opened on the thirty-seventh day after operation. In this case it might be attributed to the irritation of the drain, which passed to the pelvis, and its too early removal.

Both of the undrained cases developing late abscesses were cases of appendicitis; one with spreading peritonitis developed a subphrenic abscess; the other, an extreme case of general peritonitis, developed two abscesses in the fourth and fifth weeks of convalescence, situated among the coils of the intestines to the left of the umbilicus.

Drainage would probably not have prevented these abscesses. Of the ten cases closed without drainage four developed suppuration of the parietal wound. In one of these the

superficial wound had been drained, but insufficiently. One other case of general peritonitis from the perforation of three typhoid ulcers of three days' standing, in which I had inserted a small cigarette drain into the pelvis, leaving it only for two days, also developed suppuration of the whole parietal wound, while the peritonitis went on to complete resolution.

When I close the peritoneum in these cases I now fully drain the parietal wound down to the peritoneum.

A comparison of the duration of convalescence in the drained with that in the undrained cases shows that the average duration of convalescence in all the drained cases was 43.4 days, in all the undrained cases 25.3 days,—an average saving to each of the undrained cases of eighteen days. One of the drained cases (25) is omitted, since his typhoid delayed his convalescence. A fairer comparison is obtained by taking only the cases of appendicitis with spreading peritonitis, since it so happens that all of these cases could have been treated without drainage and that the other conditions were practically alike. In this group the average duration of convalescence of the drained cases was 34.7 days, of the undrained cases 21.8 days, —an average saving to the latter of practically thirteen days.

In the same group of cases the average length of time elapsing before the temperature struck the normal was in the drained cases 8.5 days, in the undrained cases 3.8 days,—a very marked difference in favor of the latter, showing how much shorter septic absorption lasts in the cases treated without drainage.

A comparison of the mortality in the cases treated by drainage and those without drainage would obviously be unfair unless we group the cases according to the causative diseases, and even then is unsatisfactory because the numbers are so small.

The only considerable groups are the cases of spreading peritonitis arising from appendicitis, ten in number, all of which recovered, showing no difference; the cases of general peritonitis arising from appendicitis, seven in number, of which five were drained with four deaths, and two were not drained,

both recovering; and the cases of general peritonitis of tubal origin six in number, of which five were drained with no recoveries, and one was not drained and recovered.

Two of the latter group were children, and, not wishing to remove the tubes, I drained the pelvis, hoping that the process would become localized, thus making fatal mistakes. I also erred in some of these cases in my diagnosis and made lateral instead of median incisions, thus hampering myself and prolonging the operation. I now make it the rule, when operating on females, to make, in all cases in which there is the least doubt in diagnosis, a median incision.

A *résumé* of the treatment that has given the best results in my experience may be briefly stated as:

1. Early operation.

2. Lavage of the peritoneum with large quantities of saline solution.

3. Closing of the peritoneal cavity without drainage unless the latter is absolutely indicated by the presence of non-absorbable amounts of necrotic material.

TABLE OF CASES OF SPREADING AND GENERAL PERITONITIS.—SPREADING.

No.	Age and Sex.	Cause.	Duration.	General Condition.	Amount of Peritoneum inflamed.	Exudate.	Drain.	Postoperative Complications.	Temp. Normal.	Duration of Convalescence.	Result and Remarks.
1	27 M.	Gangrenous appendicitis.	72 hours.	Fair.	Lower half.	Seropus, fibrin.	Yes.	.....	10th day.	30 days.	Recovered.
2	26 M.	Perf. appendicitis.	42 hours.	Bad.	Lower two-thirds.	Pus, seropus.	Yes.	.....	10th day.	27 days.	Recovered.
3	29 M.	Gangrenous appendicitis.	48 hours.	Fair.	Lower half.	Seropus, fibrin.	Yes.	Intestinal obstruction from pressure of drain.	11th day.	43 days.	Recovered.
4	60 M.	Gangrenous appendicitis.	36 hours.	Fair.	Lower half.	Pus, seropus.	Yes.	.....	3d day.	39 days.	Recovered.
5	21 M.	Gangrenous appendicitis.	30 hours.	Good.	Right half and pelvis.	Seropus.	No.	.....	3d day.	16 days.	Recovered.
6	16 M.	Gangrenous appendicitis.	48 hours.	Fair.	Lower two-thirds.	Pus, seropus.	No.	.....	3d day.	16 days.	Recovered.
7	23 F.	Gangrenous appendicitis.	24 hours.	Bad.	All, except about liver and spleen.	Pus, seropus, fibrin.	No.	.....	4th day.	19 days.	Recovered.
8	11 F.	Gangrenous appendicitis.	24 hours.	Fair.	Right half and pelvis.	Seropus.	No.	.....	3d day.	10 days.	Recovered.
9	25 M.	Gangrenous appendicitis.	36 hours.	Fair.	Lower two-thirds.	Seropus, fibrin.	No.	Superficial wound infection, subphrenic abscess.	4th day.	47 days.	Recovered.
10	23 M.	Gangrenous appendicitis.	26 hours.	Fair.	Lower half.	Seropus.	No.	.....	6th day.	23 days.	Recovered.
11	36 M.	Perf. typhoid ulcer.	26 hours.	Bad.	Lower two-thirds.	Pus, fibrin, fæces.	Yes.	.....	.....	.....	Died in two hours.
12	25 M.	Perf. ulcer of duodenum.	48 hours.	Fair.	All, except about spleen.	Pus, seropus, fibrin, intest. contents.	Yes.	.....	15th day.	37 days.	Recovered. Inversion ulcer with purse string.
13	20 F.	Perf. ulcer of stomach, abscess; rupture of abscess.	20 hours.	Bad, anæmic.	Upper half.	Seropus, fibrin, gastric contents.	Yes.	Subphrenic abscess.	4th day.	.....	Died tenth day, sepsis; peritonitis resolved.
14	21 F.	Perf. ulcer of stomach, abscess; rupture of abscess.	6 days, 12 hours.	Bad.	All, except small portion of lower regions.	Pus, seropus, fibrin, gastric contents.	Yes.	.....	.....	.....	Died sixteenth day, sepsis from abscess.
15	47 M.	Perf. ulcer of pylorus.	7 hours.	Good.	Right side and pelvis.	Seropus, gastric contents.	No.	.....	6th day.	22 days.	Recovered. Excision ulcer, pyloroplasty.
16	20 F.	Tubal, gonorrhœal.(?)	48 hours.	Fair.	All, except about liver.	Seropus.	Yes.	.....	5th day.	33 days.	Recovered. No bacteriological examination.
17	57 F.	Tubal, gonorrhœal.	24 hours.	Good.	Right side of pelvis and right femoral hernial sac.	Seropus.	Yes.	.....	2d day.	.....	Died thirty-fifth day, pyæmia; temp. normal for three weeks after operation.

GENERAL.

No.	Age and Sex.	Cause.	Duration.	General Condition.	Amount of Peritoneum inflamed.	Exudate.	Drain.	Postoperative Complications.	Temp. Normal.	Duration of Convalescence.	Result and Remarks.
18	23 F.	Gangrenous appendicitis.	72 hours.	Bad.	Whole greater sac.	Seropus, fibrin.	Yes.	.....	.....	.....	Died on third day.
19	18 M.	Gangrenous appendicitis.	72 hours.	Bad.	Whole greater sac.	Pus, fibrin.	Yes.	Pelvic abscess at seat of drainage 37th day.	28th day.	95 days.	Recovered.
20	38 M.	Gangrenous appendicitis.	.....	Bad.	Whole greater sac; coils of intestine appeared gangrenous in places.	Pus, fibrin.	Yes.	.....	.....	.....	Died on third day.
21	50 F.	Gangrenous appendicitis.	120 hours.	Bad.	Whole greater sac.	Pus, fibrin.	Yes.	.....	.....	.....	Died. Only partial lavage; death in ten hours.
22	12 F.	Gangrenous appendicitis.	60 hours.	Bad.	Whole greater sac.	Pus, fibrin.	No.	Superficial wound infection, pneumonia 10th day, two abscesses left side 4th week.	40th day.	60 days.	Recovered. Streptococcus and colon bacillus.
23	25 F.	Gangrenous appendicitis.	48 hours.	Fair.	Whole greater sac.	Pus, seropus, fibrin.	No.	Superficial wound infection.	5th day.	20 days.	Recovered.
24	68 M.	Gangrenous appendicitis.	80 hours.	Moribund.	Whole greater sac.	Pus, fibrin.	Yes.	.....	.....	.....	Died in three hours.
25	16 M.	Perf. three typhoid ulcers.	72 hours.	Bad.	Whole greater sac.	Pus, seropus, fibrin, fæces.	Yes.	Superficial wound infection.	3d day.	52 days.	Recovered. Small cigarette drain only; recrudescence typhoid fourth day.
26	24 M.	Perf. ulcer of ileum, probably tubercular.	48 hours.	Fair.	Whole greater sac.	Pus, seropus, fibrin.	Yes.	.....	.....	.....	Died fourth day.
27	6 F.	Tubal, probably pneumococcus.	.....	Bad.	Whole greater sac.	Creamy pus.	Yes.	.....	.....	.....	Died ninth day; autopsy report pyæmia.
28	27 F.	Tubal, gonorrhœal.(?)	144 hours.	Bad.	Whole greater sac.	Pus.	Yes.	.....	.....	.....	Died second day, sepsis.
29	30 F.	Tubal, gonorrhœal.(?)	36 hours.	Fair.	Whole greater sac.	Seropus, fibrin.	Yes.	Vulvulus 3d day.	.....	.....	Death followed second operation for intestinal obstruction; no bact. examination.
30	4 F.	Tubal, gonorrhœal.	.....	Bad.	Whole greater sac.	Seropus.	Yes.	.....	.....	.....	Died in twenty-four hours.
31	13 F.	Tubal, gonococcus and streptococcus.	72 hours.	Bad.	Whole greater sac.	Creamy pus.	Yes.	.....	.....	.....	Died on fourth day from sepsis.
32	18 F.	Tubal, gonorrhœal.(?)	96 hours.	Fair.	Whole greater sac.	Pus, fibrin.	No.	.....	.....	20 days.	Recovered. No bact. examination.

A PROPOSED METHOD OF RETRODUODENAL CHOLEDOCHOTOMY FOR THE REMOVAL OF IMPACTED CALCULI IN THE RETRODUODENAL AND PAPILLARY PORTIONS OF THE COMMON BILE-DUCT.

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TRANSDUODENAL choledochotomy, first suggested by McBurney, of New York, is an operation by which, it is claimed, the removal of impacted stones in the retroduodenal and papillary portions of the common bile-duct may be readily and satisfactorily accomplished. Yet it is a procedure attended with sufficiently grave risks to cause us to resort to its use only when all other methods for removing the calculi have failed. Besides the difficulty that may be experienced in finding the duodenal papilla, the opening of the duodenum is always a serious procedure. The danger lies not so much in a primary peritoneal infection as in the possible insufficiency of the closing sutures. A small duodenal fistula tends to become larger; spontaneous closure is most unlikely, and death from inanition would be the natural consequence. The writer knows of one such case in which, after a transduodenal choledochotomy, a leak in the duodenum occurred, and death from inanition resulted. Such insufficiency of the suture line cannot be attributed to an improperly placed suture. For it must be remembered that in these cases of long-standing, impacted calculi in the gall-bladder and ducts, the peritoneal covering of these parts has been repeatedly inflamed. Numerous adhesions have formed, and the peritoneum has lost to a considerable degree its quality of adhesiveness. This alteration in the peritoneum accounts for the failure of a very carefully placed suture to effect a perfect closure of the duodenum.

To obviate the necessity of opening the duodenum the writer has thought of a retroduodenal route for access to the retroduodenal and papillary portions of the common bile-duct. Such a method of approach necessarily demands a mobilization of the descending portion of the duodenum sufficiently to permit of its rotation to the left around a longitudinal axis passing through its inner border. The feasibility of such mobilization and reflection of this portion of the duodenum in the living subject has been demonstrated by Kocher, who has employed it in five cases for the purposes of gastroduodenostomy (*Centralblatt für Chirurgie*, 1903, No. 2).

The writer has had no opportunity to test the value of the retroduodenal method of attacking the retroduodenal and papillary portions of the common bile-duct in the living subject. By the kindness of Dr. Gallaudet, of the College of Physicians and Surgeons, Columbia University, he was enabled to test its practicability upon the cadaver. It was especially noted that the posterior parietal peritoneum in this region and the descending portions of the duodenum are very loosely attached to the abdominal wall, and that their separation from the posterior parietes and the reflection inward of the duodenum are very easily accomplished. In a subject with the arteries well injected, no vessels of any importance were encountered. The pancreaticoduodenal arteries lie about one-quarter of an inch anterior to the duct, and run in a course parallel to it. A small vein was noticed to cross the duct just before its entrance into the duodenum. Exposure of the entire retroduodenal and papillary portions of the duct was excellent, and manipulations with it were easily carried out.

The steps in the operation of retroduodenal choledochotomy are as follows:

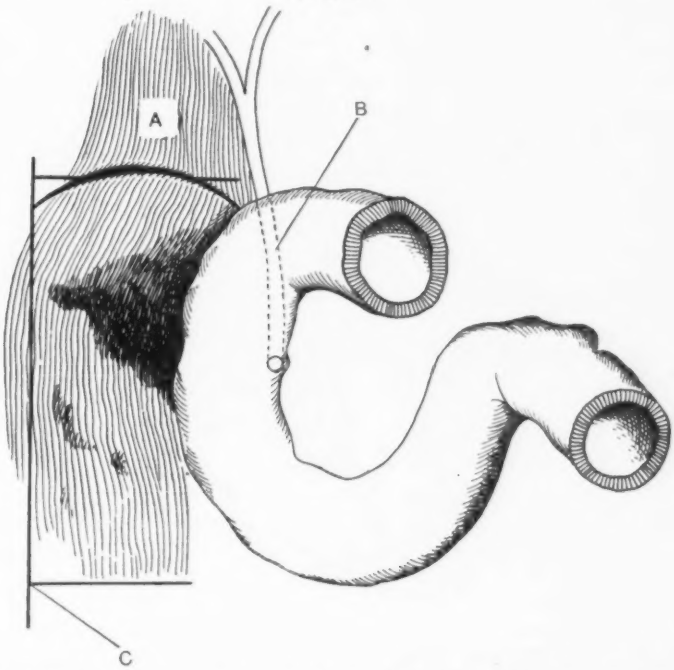
A small, round, hard cushion should be placed under the lower dorsal region of the patient. This throws the posterior abdominal parietes forward and renders more accessible the descending duodenum, common bile and cystic ducts.

1. Abdominal incision through the right rectus muscle, extending from the costal arch to the umbilicus.

2. Free exposure of the descending portion of the duodenum; all surrounding adhesions are freely separated, or, when vascular, divided between two ligatures. The liver is drawn upward by a broad retractor, the stomach pushed over to the left, and the transverse colon downward by gauze compresses and held away by the assistant.

3. Mobilization of the descending duodenum. Three or four centimetres external to the right border of the duodenum,

FIG. 1.



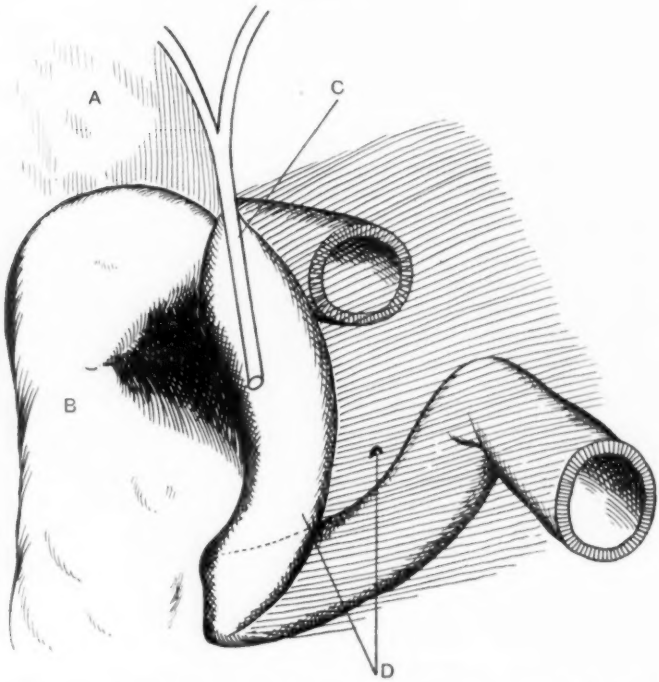
A, Hepatorenal ligament; B, retroduodenal portion of choledochus brought anteriorly by reflection of duodenum to left; C, line of incision for reflection to the left of peritoneum and duodenum.

the posterior parietal peritoneum is incised (Fig. 1) in a longitudinal direction from the flexure of the duodenum above to the transverse mesocolon below.

With the finger, the internal or left portion of the divided peritoneum is elevated from the parietes up to the right duo-

denal border; the finger then passes behind the duodenum, gently separating it up to its inner border, from the vertebræ, inferior cava, and aorta. The duodenum is now only loosely fixed at its flexure above, at the transverse mesocolon below, and along its inner concave margin, and is easily rotated to the left around a longitudinal axis passing through its inner

FIG. 2.



A, Hepatorenal ligament; B, right kidney; C, retroduodenal portion of choledochus brought anteriorly by reflection of duodenum to left; D, duodenum and peritoneum reflected to the left.

margin. This rotation brings its posterior surface and the retroduodenal and papillary portions of the common duct anteriorly, and affords an excellent exposure of these parts (Fig. 2).

(The relation of the duct to the neighboring parts is as follows. The duodenal branch of the pancreaticoduodenal

artery lies anteriorly to the duct, and separated from it by about one-fourth of an inch. The accompanying vein lies just behind the duct; in some instances a branch of the vein crosses it just before its entrance into the duodenum. The superior mesenteric branch of the portal vein is considerably internal to the duct, and the vena cava posteriorly to it.)

The duct is easily recognized; it can be grasped between the fingers, incised, and calculi impacted in it removed.

4. *Toilet.*—The site of incision into the duct should be covered by a narrow wick of gauze, and the descending duodenum allowed to fall back into its original position. If it is necessary to drain the common bile and hepatic ducts, the common duct is incised in its free portion in the gastrohepatic ligament, and a drainage tube inserted into this opening. The incision into the retroduodenal portion of the duct can be easily sutured, though this should not be necessary.

Upon the cadaver, the operation appears to be an eminently satisfactory method of access to the retroduodenal and papillary portions of the choledochus. The writer begs of those who think well enough of it to try it and report their results.

A CHEMICAL HYPOTHESIS FOR THE ETIOLOGY OF CANCER.[1]

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In all the vast literature upon the etiology of cancer, little or nothing has been contributed towards the possibilities of its chemical or chemico-biological origin. Before anything was known of parasitology, Sir James Paget expressed his belief in both a local and constitutional cause; but such terms were very vague then, though now with the recent discovery of the almost universal presence of enzymes in living tissue, and with the added facts supplied by the chemistry of the blood, a reasonable working hypothesis can be constructed. And it is the more worthy of study in that, in spite of all the great labor which has been expended in the search for a bacterial origin of the disease, the net result at present seems to be a verdict of at least "not proven." Even now the pathological chemistry of the blood is still in its infancy, although to it is ascribable the ultimate cause of all deaths. In those due to bacteria this chemistry seems almost hopelessly complex; but there are a very large class of disorders, notably those of which arterial sclerosis is a type, which to be sure seem equally little understood, but which ought to be more accessible to the test-tube. These, which can perhaps properly be called the chemical disorders of advancing life, are often associated with cancer, and any study of the chemical constitution of the blood in the latter condition should shed some light upon the other very common derangements. The simpler elements and compounds have been pretty thoroughly investigated with a general negative result, but the more com-

[1] Read before the New York Surgical Society, April 22, 1903.

plex organic bodies, like the carbohydrates and proteids, have scarcely been considered, and it is to them I wish to call attention.

In the last United States Census Report the greatest increase in mortality is shown to be in nephritis, apoplexy, influenza, cancer, old age, and heart disease. With the exception of influenza, and for the present of cancer, all the rest may be said to belong to the connective-tissue degenerations, an evident disorder of metabolism which is universally ascribed to some "irritant" circulating in the blood. But, so far as I know, the exact character of this irritant or blood derangement has not been determined; and, indeed, its actual nature seems only inferred from the similar changes produced by bacterial and other poisons. That it is chemical seems, however, admissible, if only from the very close analogies with the pathological findings in chronic alcoholism. Granted so much, and we come immediately to diet and mode of life, which are universally conceded to be intimately connected with every disease, but chiefly with disorders of metabolism, that is those which are purely chemical. This group of diseases, so prominent in the census report, accompanies general prosperity, wealth, good and easy or strenuous living, with its nervous strain and interference with proper assimilation, oxidation, and excretion. The association is not as problematical as might at first sight appear, as it emphasizes the chemical nature of the problem involved, and cancer is constantly appearing under such conditions. It seems most common in the well-to-do, the well-fed, and the sedentary, and attention has frequently been called to its connection in the same sense with gall-stones. The statistics compiled to show infected localities and houses, though intended to bring out the possible bacterial origin, have always seemed to me equally applicable to diet and mode of life, for low-lying rich soils along river bottoms are more productive and give greater creature comforts and ease than hill-sides and rocky soils. That certain dwellings or families suffer more than others speaks no more for contagion than it does for cerebral hæmorrhage or

senility. The inhabitants may prefer or be forced to live in the same way. Heredity, an exceedingly vague and uncertain matter by the way, though estimated as traceable in from 10 to 35 per cent. of all cases of cancer, has about an equal significance. There is also a somewhat apparent parallel in the occurrence of goitre in certain regions and peoples. All that is known about these factors points towards a chemical influence. The Teutonic and allied races are notoriously subject to malignant disease, and the sufferers from the malady have always seemed to me to present many close analogies to the well-to-do of other races. They are generally well nourished and fond of eating and alcoholic drinks, and are more or less sedentary and phlegmatic in their habits. In the lower animals cancer seems to be unknown below the mammalia, and of these the carnivora, and particularly the omnivora, are much more subject to it than the herbivora, and apparently the more highly-bred and domesticated the animal the more apt it is to be attacked by cancer.[1, 2, 3] These facts taken singly would have little significance, but grouped together and considered with the practical disproof of the parasitic theory, they are very suggestive. The means other than operative which have been found capable of ameliorating or curing cancer in a few undoubted instances can all be considered chemical in their nature and acting through the blood. The successes in the treatment of sarcoma by the injection of the erysipelas or mixed toxins can only be thus interpreted. To be sure, this is generally considered as evidence of the bacterial nature of the affection; but there is no other proof than analogy, and the cure, though evidently chemical, may be susceptible of a simpler explanation than Ehrlich's theories of the mechanism of immunity would indicate. A possible hint towards the solution is supplied by the fact that during infectious diseases the carbohydrates of the body, and particularly glycogen, are markedly decreased in amount.[4] The starvation of malignant tumors by cutting off their blood supply,[5] a method much advocated by a member of this society, seems to have considerable significance, especially when considered in relation

to the results obtained by thyroid feeding and oophorectomy. Oophorectomy in young animals, as is well known, has a pronounced influence on the development of the other sexual organs, and to a much less extent upon the whole organism. Certain experiments have proved that this is due to some internal secretion, probably an enzyme which is given off by the ovaries, and which, to insure normal growth, is evidently a necessary constituent of the blood.[6] Its effect is no more remarkable, of course, than that of the secretions of the thyroid gland and the suprarenal bodies, except in its selective influence upon the growth of certain organs and portions of the body. In other words, certain cells must require a particular kind of nutriment, or modification of the ordinary nutriment produced by the ovarian enzyme, in the blood. The endless attempts at inoculation by transplantation of cancerous tissue, to have any reasonable hopes of success, show that animals of the same species must be employed. The rarity of this success, however, might be inferred from the practically unknown inoculation of the operating surgeon, but auto-inoculation, even if it needed other demonstration than the occurrence of metastases or recurrence, is uniformly successful. A proper soil seems to be therefore a necessity, and this can be sought in nothing else than the constitution of the circulating blood, and I shall try to show that the carbohydrate group ought to be the first to be examined. In the first place, the recent discoveries as regards enzymes and their existence in all parts of the living body, and their necessity in metabolism, have already been referred to. Every tissue appears to assimilate its nutriment and to carry on its existence by means of its enzymes and the reversibility of their action.[7, 8, 9, 10] Only a few of these mysterious entities have as yet actually been proved capable of reconstructing the complex organic bodies from the simpler soluble and diffusible substances into which, ever since the beginning of physiology, the digestive enzymes have been known to resolve such bodies. Nevertheless, there now appears to be no reasonable doubt but that this is the method by which all living matter exists. There are in general

the three main groups of enzymes,—the proteolytic, the amylolytic, and the lipolytic,—corresponding to the three main groups of food stuffs, to which must be added a fourth or oxidative enzyme. Each tissue possesses one or more of the enzymes of these groups, although each enzyme, according to its origin, exhibits some peculiarity or selective action. The proteolytic enzymes of the lung, for example, can digest insoluble lung proteids, while the similar enzymes derived from the liver cannot do so. The proteolytic enzymes of either lung or liver, however, can digest the albumoses obtained from lung proteids. The albumoses, by the way, are one of the first cleavage products of all proteid digestion.[11] Conversely, it is presumable that, like lipase, which reconstructs fat from fatty acids and glycerin, lung tissue can only be kept in repair by its own enzyme. It has been known for some time that cancerous tissue contained enzymes, but I am indebted to some as yet unpublished researches of Dr. Buxton, at the Cornell Medical College, for the knowledge that the most abundant and constant enzyme present is amylolitic. He will not affirm that its amount is directly proportionate to the malignancy of the tumor, though, from what is known of the ordinary digestive enzymes, which vary according to the work they are required to perform, this seems possible of inference. However this may be, glycogen, which is the animal equivalent of starch, is found in all tumors in a quantity varying directly with the malignancy of the disease.[12, 13, 14, 15] It is a colloidal, non-diffusible body, and its presence in the cells can only be explained by virtue of the enzymes they are known to contain.

There remains now the adjustment of the details of this hypothesis for the local and constitutional origin of cancer to the clinical facts, and the means of proving it. The individual cells of a malignant growth bear a very close resemblance to the fœtal embryonic type, and are notoriously hard to differentiate from those of granulation tissue. Both fœtal and granulation tissues are also peculiar in being rich in glycogen, which gives the first suggestion for approaching the problem, and from Dr. Buxton's work I know that granulation

tissue contains considerable amylase. Traumatism in one form or other is universally accepted as about the only apparent constant cause of cancer, and it is always accompanied by more or less of an attempt at repair by granulations or an infiltration of embryonic round cells. In constructing a hypothesis for the origin of cancer, it is not departing too much from the facts to affirm that these, by their enzyme, assimilate from the blood the carbohydrate to form the glycogen necessary for their life and growth, and by the excess of nutriment present and their own exuberant vitality in given instances proceed to outgrow their natural limits in the shape of malignancy. It is conceivable that ordinarily the residue of the original destruction (using the analogy of the lung and its proteolytic enzymes previously referred to) may supply the food required to start the reparative process, as the enzymes of each part have a selective action, and to complete their function seem to need a food represented in the body of the cells from which they are derived. Ordinarily, when this is exhausted, the enzymes of the surrounding tissues neutralize any excessive cellular reproduction and repair is natural. If there is an excess of food or of enzyme, however, malignant degeneration follows. The comparative rarity of the indefinite continuation of this reparative reproduction or its inception in some other way do not seem to me insurmountable obstacles to the theory suggested above. Adami has called attention to the need of a theory which will cover the cause of all tumors as their original source, and the lines differentiating the numerous growths and allied disorders are so indistinct as alone to show their relationship. The matter of age seems to have some bearing on the problem, and it is not so much the age of the patient as that of the particular organ attacked, for malignant disease is apt to affect those which have reached the limit of active growth. Sarcoma, for example, occurs in bones at the epiphyses as they become bony, and carcinoma in glands like the mamma at the menopause. That there is a "habit of growth" is merely a statement and not an explanation, and scarcely accounts for those cases which, according to Cohnheim's theory,

develop from misplaced embryonic cells or from benign embryonic tumors like the teratomata after they have remained dormant for a longer or shorter period. These misplaced "cell rests" appear to be common enough in the lower animals and give rise to no particular disturbance. That in man they should now and then produce malignant tumors is explainable on the hypothesis of the presence of a nutriment similar to that found in the fœtal environment of these cells and brought into existence by the diet or mode of life of the subject, or to an enzyme started into activity by some unnoticed injury, or to a combination of all these factors.

Some cases of sarcoma have recovered after operative removal, and yet more or less diseased tissue has been left behind. There are no similar records as regards carcinoma, although, at least, one well-authenticated case, apparently after existing some time, has recovered spontaneously. It is significant in that glandular tissue contains more enzymes than other structures, although they all contain some amylase. In other words, the cells of sarcoma belonging to the connective-tissue group have not the excessive energy in the shape of enzymes needed to maintain the malignancy of the original focus. On the other hand, some malignant growths recur worse than ever after operation. But following hæmorrhage, the blood is found experimentally to contain an increased quantity of sugar which might be supposed, for purposes of this hypothesis, to afford more nourishment to the disease; or, if this were untenable, the restraining effect of the normal surrounding enzymes might be conceived to be inhibited as a result of the general depression or shock of the interference. Their analogues, the digestive enzymes, are certainly disturbed under such conditions.

However fanciful some of these explanations may be regarded, they serve to indicate how the hypothesis of a combined local and constitutional cause of cancer can be made to apply to the numerous clinical observations. The apparent cures effected by the X-rays, for example, harmonize with this in that it is known that they have an inhibitive or in-

jurious effect upon many enzymes, and particularly upon diastase, a close relative of amylase.[16] The latter does not seem to have in itself been thus studied. To my mind, there is thus enough evidence to warrant a chemical investigation of the blood, and particularly of its carbohydrate constituents. The rarity of the simultaneous occurrence in the same subject of sarcoma and carcinoma might seem to complicate the study by suggesting the need of a search for two different substances, but with the many similarities in the age and general characteristics of the cells or tissue attacked, and the variations in the carbohydrates and local enzymes, it is not probable. The carbohydrate food stuffs as introduced into the alimentary tract, and from which the animal carbohydrates must be chiefly derived, include a large group of principles whose general formula can be represented as $(C_6(H_2O)_n)_{n'}$, or six atoms of carbon united with a definite amount of water and the whole raised to the $_{n'}$ power. This may be formed by the union of CO_2 plus H_2O, which equals CH_2O plus O_2, and subsequent polymerization, as $6(CH_2O)$ equals $C_6H_{12}O_6$, or as a cleavage product from proteid matter by enzymes. There are other theories, but these serve as simple examples. However produced, the carbohydrates are divided into three main groups, namely,

The amyloses or polysaccharides $(C_6H_{10}O_5)_n$, including cellulose, starch, and glycogen.

The saccharoses or dissaccharids $(C_{12}H_{22}O_{11})$, including maltose and cane sugar.

And the glucoses or monosaccharids $(C_6H_{12}O_6)$, including glucose and levulose.

The most convenient and reliable method of testing is by Fehling's solution, although the first two groups—the amyloses and saccharoses, to give the reaction—have first to be hydrated or inverted by boiling with acids. Superficially, the matter looks simple enough, but in the body there are some carbohydrates which are not thus easily capable of reducing copper. They often contain nitrogen, and are known as glycoproteids, of which mucin is an example. This body can be made to

yield a non-reducing carbohydrate, which by appropriate treatment can still be made into a cupric oxide reducing but non-fermentable sugar.[17] As mucin is so abundant a constituent, especially of the connective-tissue group of organs, and pathologically of many structures in myxœdema, between which and cancer numerous analogies have been drawn, the glycoproteids seem worthy of serious attention. In fact, some by-products I have obtained in the course of analyses are very suggestive in their physical properties of such a glycoproteid. I began examining the blood obtained during operations on cancer and other patients two years ago, and have particularly to thank Dr. Willy Meyer for many courtesies. The blood was received in absolute alcohol in a tall 100 cubic centimetres stoppered cylinder as it flowed from the wound. The exact quantity could thus be ascertained, and was preserved indefinitely by the alcohol, which at the same time presumably holds in solution all the glucose. It also precipitates proteids, together with the blood enzymes, which, even after months of preservation in alcohol, I have found capable of extraction from the precipitate by a 50 per cent. solution of glycerin and without alteration of their properties. The glycoproteids are also precipitated with the proteids, and among these bodies may be counted jecorin, a reducing substance said to be a compound of lecithin and a carbohydrate which is soluble in ether and in dilute but not in absolute alcohol.[18, 19, 20] The above brief *résumé* suggests various lines of procedure differing quite considerably in detail, but with the general object of isolating some carbohydrate which would be constant in cancer blood. My early results were somewhat variable, but seemed to warrant perseverance, and this winter, under the guidance of Dr. Wolf, the physiological chemist at the Cornell Medical College, the analyses were continued, using alcohol to receive and preserve the specimens as before. The specimens averaged from fifteen to twenty cubic centimetres of blood, and even a smaller amount than this I have found capable of very accurate manipulation. By Dr. Wolf's advice, the glucose, being the simplest to investigate of all the possible

carbohydrates, was chosen as the first line of research. The alcohol containing it in the cylinder was filtered, evaporated to dryness in vacuo to avoid hydrolysis, and the residue of this filtrate extracted with water. An opalescent mixture resulted, quite suggestive of glycogen in appearance, which gave a heavy precipitate by treatment with a few drops of concentrated HCl and phosphotungstic acid. The filtrates from this have shown a pretty constant amount of glucose in specimens which were taken from patients suffering from every kind of surgical disease and of all ages. This might seem disappointing, but as the only disease which seems to be incompatible with the coexistence of cancer, namely, diabetes, has an excess of glucose in the blood, it is reasonable to suppose that some other carbohydrate ought to be sought for. Nevertheless, with the improved technique suggested by Dr. Wolf, so few of my analyses have been completed, that I cannot speak as yet with any degree of positiveness. At the same time that glucose was sought in the alcoholic filtrate, the original proteid precipitate, after being thoroughly washed with alcohol and rubbed up with sand, was treated with twice the volume, of the recorded amount of the specimen, of a 50 per cent. glycerin and water solution. At the end of forty-eight to seventy-two hours a definite amount of this glycerin extract was tested for its amylolytic and glycolytic powers. It is worthy of note that the amylolytic blood enzymes seem quite variable in power in the different specimens. But as yet I can make no definite statements nor draw any conclusions upon this part of the work. It is evidently one, however, which must be thoroughly sifted. The glycolytic enzyme in the blood is much disputed by numerous competent observers. The sources of error are obvious in that glucose is a most fermentable product, and the slightest bacterial contamination would vitiate results. But from the gross appearance of the reduced copper, which is used to measure the action of the supposed glycolytic enzyme upon a definite quantity of glucose, my results have seemed to favor the theory of the presence in the blood of a marked glycolytic enzyme. The subjects which are at the same time the

simplest and the most necessary to clear up are the blood enzymes and their comparative vigor or abundance in all ages and kinds of disease as well as in health and the glucose which is always present to a certain extent. I have hitherto neglected the glycoproteids, notably, jecorin, and after the matter of the enzymes and the glucose has been determined this seems the next to be taken up, combined possibly with receiving the blood as shed in ether instead of alcohol. In examining the aqueous extract of the original alcoholic filtrate, the consideration of the carbohydrates, which are only detectable by Fehling's solution after inversion, forms an interesting problem, which I regret that as yet I can cast little light upon. These bodies consist of the amyloses and saccharoses, and should have a very important bearing on the problem, as I have found that they are present, but have not been able to demonstrate any characteristic relative quantitative amount.

The above brief sketch I trust will serve to show some reasons for approaching cancer from a new direction, and possibly induce some better equipped chemist to undertake what cannot be a profitless study, as to be of any value the blood must be examined in health and disease and at all ages, and a comparison then made. Clinically, it looks as though the result to be expected is a quantitative and not a qualitative change in the chemical constitution of the blood.

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THE METHOD OF INFECTION OF ACTINOMYCOSIS IN MAN.[1]

WITH A REPORT OF FIVE CASES.

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MEN, as well as domestic animals, are subject to infection with the ray fungus, but the transmission of the disease from the one to the other seems to be of rare occurrence. The published cases of human actinomycosis in their majority do not prove that the patients came in contact with diseased animals, in spite of the fact that the patients mostly came from rural districts. Laboratory research has shown that the fungus is attenuated by passing through the animal body. The microbe has been found thriving on grain, and in actinomycotic ulcers of man as well as of animals sheaths of grain have frequently been found. Many of the patients are reported as habitually using straw for tooth-picks, chewing straw or raw grain, or sleeping on straw, etc. From these and similar observations one has come to the conclusion that man, as a rule, does not contract actinomycosis from domestic animals, but from grain and grain products.

I intend to speak referring to personal observation about the source of human actinomycosis, the place of entry, and the conditions of the organs necessary or favorable to the infection.

Two of the patients, both strong and otherwise healthy young men previous to their illness, were occupied in unloading a stranded wheat steamer in Lake Erie, and frequently chewed the raw grain. I saw one of them in consultation with the attending physician. A hard, diffuse swelling presented itself at the neck below the angle of the mandible. At a previous operation no pus had been found, and at the second one,

[1] Read before the Medical Society of the County of New York, April 27, 1903.

done in my presence, not more than one tablespoonful was evacuated. I took a specimen of this pus and found it to contain the fungus. The second patient was exhibited by Dr. Sanderson, of Windsor, Canada, at the Detroit Medical and Library Association, without having been operated upon, and lacking a microscopical proof. The symptoms were exactly the same. From analogy with his comrade the diagnosis seems to be justified. No further comment on the source and method of infection is necessary in these two instances.

Of my other three patients, two lived on farms near, and one in the suburbs of, Detroit, Michigan, with farms in the immediate neighborhood. In spite of repeated inquiries, nothing could be learned about diseased animals and chewing of raw grain, etc. When patients have come in contact with animals suffering from actinomycosis, they hardly can fail to notice it. It seems sure, therefore, that these patients must have contracted the disease from grain, or at least from something outside the animal kingdom. As chewing of raw grain was denied, the question arises whether grain products, after having been prepared in the kitchen, may still carry the virulent fungus. From experiments made to learn the effect of wet and dry heat on the fungus, it seems to be certain that the cooking and baking processes will destroy it. Under such circumstances, one is inclined to accept the lung as the place of entry in the above cases. Chances to inhale the microbe are abundant on farms, especially during the threshing season. As will be shown later, this mode of infection finds support in only one of the cases. Even here it is not the only possibility, and contaminated food would offer just as good, or better, an explanation. It seems to me that only the dust fallen on fruit, lettuce, and similar products or into open wells remains. In the literature, I found nothing in support of such a possibility. It may be a suitable object for bacteriological investigation, and perhaps another reason to cover open wells on farms.

After proving that the alimentary canal need not be excluded as the primary seat of the disease in our cases, let us

see in which direction the special circumstances point. Two of the patients, both females, never had any pulmonary symptoms whatever. Actinomycotic abscesses were opened far distant from the lungs at the lower abdomen on the left side, and spread from here to the navel in one and the gluteal region in the other patient. In one case I did not obtain the permission to attempt a radical operation, in the other the process seemed too far advanced to make such a proposition justifiable. The original point of infection, therefore, was not laid open. The question, what may be found after opening the abdominal cavity in cases with actinomycotic abscesses at the region described above, is of theoretical as well as practical interest. According to the history of the cases, the disease was doubtless of internal origin. The two organs to be considered are the uterine appendices and an intestinal loop. As primary actinomycosis of the former is extremely rare, and perhaps not yet diagnosed, beyond doubt only the latter remains. In both cases, therefore, the infection has taken place through the alimentary canal. The question, which part of the tract was involved, will be discussed later.

An objection to this, based on experimental research, may be made here, and has to be disposed of first. The disease promptly develops if the fungus is brought directly into the animal tissues, and always fails to do so after simply feeding virulent cultures. It seems, therefore, that the carrier of the microbe must be able to penetrate the surface of the gut, as it easily may happen in the mouth by chewing straw, etc. But how can this be perfected by the substances pointed out above, as the only source of infection in our cases,—lettuce, well water, etc.? It may be that some points in the histories of my patients lead us in the right direction. One of these patients was recovering from typhoid fever when the actinomycotic process came to the surface. The attending physician was most positive in his diagnosis, and stuck to it after later developments. The fever, the stool, and the roseola had been typical. I operated under the impression that a perforated typhoid ulcer had caused an abscess, and was very

much surprised to discover the ray fungus in the scanty, thick pus. The inoculation of a typhoid ulcer from well water would be a very satisfactory explanation. Consulting the literature, I could not find anything very conclusive in this respect. One case is reported by Dr. Lange in the ANNALS OF SURGERY, 1896, p. 371, with typhoid-like symptoms preceding the formation of an abdominal actinomycotic abscess. In other publications, no hint is given that the usual symptoms of intestinal actinomycosis—fever, diarrhœa, and blood in the stool—were of a character to suggest typhoid fever. Special attention being given to this point in the future, some true cases of typhoid may be diagnosed where it was not formerly suspected. That such a relation between the two diseases is of frequent occurrence cannot be assumed. It hardly would have escaped detection for such a long time, as actinomycosis is known already. It may be that in my case the occurrence of both diseases is simply a coincidence. The question cannot be decided definitely without post-mortem findings, the Widal test, or at a radical operation.

As mentioned before, one of the reported cases conveys the impression as being one of primary pulmonary actinomycosis. The patient, who never had any pulmonary symptoms previously, was suddenly seized with severe coughing spells. There was hardly any sputum raised, but a very offensive odor emanated from the lung with each attack. An aspirator inserted between the lower ribs of the right side withdrew offensive pus. At the operation, I found an abscess distinctly situated in lung tissue of about a hen's-egg size and actinomycotic in character, as microscopical examination proved. The patient suffered from diabetes at the same time, and died in coma a few days later. Additional to the lung abscess, two others were found at the post-mortem,—one in the liver, the other surrounding the upper half of the right kidney, all three in continuous communication through narrow channels. They contained very little pus, and did not produce any enlargement of the organ which could have led to their discovery before or at the operation. No ulcers, scars,

or strictures were found in the alimentary canal. The appendix was freely movable, contained two small semi-solid particles of brownish color, and its mucous lining seemed to be normal. A coil next to it was folded upon itself by an adhesion. With this additional knowledge, let us reconsider the diagnosis of primary pulmonary actinomycosis. As no actinomycotic process was found in the intestinal canal, the lung was the only one of the affected organs communicating directly with the outside. A small particle having virulent germs could produce the necessary lesion in the tender lining of the smallest air passages. Nevertheless, I cannot accept the original diagnosis as an indisputable one. The reasons are as follows:

(1) According to other writers, primary intestinal actinomycosis may heal spontaneously, and the secondary process continue to spread. (2) Primary intestinal actinomycosis in by far the majority of cases is situated at the appendix or colon. (3) My patient passed through a typical attack of appendicitis, which left slight evidence revealed at the post-mortem. (4) An abscess of the liver, secondary to an appendiceal process and located between the lung and kidney abscesses, could perforate more easily into both of these organs than a primary lung abscess could do, situated at one end of the row of abscesses.

At the time of the post-mortem, the possibility of primary abdominal actinomycosis did not occur to me, and I may have lost here a very valuable link in the chain of evidence. A microscopical examination of the concrements in the appendix, which I failed to make, could have shown the presence of the fungus, and thereby render the arguments for primary appendiceal actinomycosis and secondary liver abscess almost indisputable. Under the circumstances, we must content ourselves by admitting both ways of infection, and aiding through our loss future observers.

I return now to the intestinal ulcers as places where the ray fungus may enter the system. There are no cases, or very few, reported of ulcers of the stomach, tubercular, syphi-

litic, or carcinomatous ulcers of the small and large intestines becoming actinomycotic. It seems, therefore, that these large, open, chronic lesions are not the ground favorable to the growth of the microbe. The fact that actinomycosis of the lung mostly occurs at the lower lobe, contrary to tuberculosis, does not necessarily mean antagonism between these two diseases. Inhaled particles laden with the germ may rather fall into the lower than the upper part of the lung. But the non-occurrence or rarity of actinomycosis on the open intestinal ulcers described above rather indicates that fresh accidental lesions are needed by the microbe, as sheaths of grain and similar bodies may produce them. The large intestine is certainly more favorable for such an occurrence than the small intestine. Sharp bodies protruding from solid scybalæ are pressed against the mucous lining of the large intestine. As this organ, therefore, is exposed evenly over its whole course, there should be no predilection of the disease for any particular part of it. But such is not the case. Actinomycosis is most frequently found at the cæcum or the appendix and at the rectum. Other writers have tried to explain this by the sluggishness of the gut, which is most pronounced at the two mentioned localities. If we combine the two points, it results in a continued contact of infected material with the wounded surface. A more acceptable explanation can hardly be given with our present knowledge.

We are now perhaps in a position to locate more definitely the origin of the disease in the two female patients with abscesses at the lower left abdomen. The rectum being a place of predilection, it is almost certain that the fungus found there its place of entry. In the case of the patient with typhoid fever, we must certainly leave some room for doubt. At the time I operated on these patients, the primary process was either healed or too high up in the rectum to be reached by the exploring finger. Such considerations are certainly important regarding operative interference for abscesses at the lower left abdomen, but cannot be dwelt upon in a paper on the etiology of human actinomycosis.

It is hardly necessary to mention that typhoid fever and diabetes may be of etiological importance, in so far as they lower the resisting power of the tissues against the entrance and growth of the microbe. In both patients—the one with typhoid and the one with diabetes—the disease took a rapid course.

In looking over again the arguments furnished by our cases and collected from the literature, we find the wounded surface very acceptable as a necessary predisposing cause of actinomycosis. But to fully recognize the details of the process more proof is needed. This may be obtained artificially in the laboratory, and more conclusively in certain geographic localities by observing the method of nature. First, in Russia, where, contrary to other countries, actinomycosis of the skin is the most frequent form of the disease in man. Second, at those places where cattle grazing on salt marshes frequently flooded by the sea are reported to be especially exposed to actinomycosis. In both instances it cannot be so very difficult to ascertain whether some injury occurred previous to the development of the disease, and whether the infection was done by the injuring article itself, or by secondarily introducing infected material. This latter point is especially important in regard to intestinal actinomycosis, as we have pointed out above. As far as human beings are concerned, an anamnestic inquiry has to bring out the desired facts. In the case of cattle, it would be necessary to make a thorough and frequent examination of the animals for wounds in the mouth. Shells and sand left by the receding water on the grass may easily produce abrasions and cuts. The infection must not necessarily take place at the marshes. If the sores are there, the microbe-bearing particles may enter later, when the animals are fed in the stable on grain products. Such investigation may also lead to preventive measures for both man and animal.

In conclusion, I enumerate the facts or disputed points which are made prominent by the cases of actinomycosis, forming the basis of my paper.

(1) The diagnosis of "primary pulmonary actinomycosis," even in the absence of all abdominal symptoms, must remain doubtful without a post-mortem examination.

(2) In abdominal as well as in pulmonary actinomycosis, the patient should be closely questioned regarding any previous more or less indistinct symptoms of appendicitis and sores at the anus.

(3) Fæcal concrements found in the appendix in cases of actinomycosis should be microscopically examined.

(4) In actinomycosis following typhoid-like symptoms, a Widal test should be made.

(5) At the post-mortem, special attention must be paid to intestinal scars, which may easily avoid detection.

(6) Experiments and clinical observation indicate that the fungus cannot enter the human or animal body without a wounded surface.

(7) Must the wounded body also be the carrier of the infectious material, or can infection take place secondarily through a granulating accidental wound or the chronic ulcers mentioned above?

(8) Human actinomycosis of the skin or actinomycosis of the jaw in pasturing cattle may offer a suitable object for investigation in regard to point No. 7.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY.

Stated Meeting, April 8, 1903.

The President, LUCIUS W. HOTCHKISS, M.D., in the Chair.

SUTURE OF FEMUR FOR NON-UNION.

DR. JOHN F. ERDMANN presented a man, eighteen years of age, who, in getting off a car May 30, 1902, fell and fractured his right femur. He was first seen by Dr. Erdmann, August 27, 1902, thirteen weeks after the occurrence of the accident. There was then non-union, with overriding at the lower and middle thirds: the fragments were displaced anteroposteriorly, with the lower fragment behind. On measuring the limb, there were found to be two and three-quarters inches shortening as compared with the opposite side. There was no swelling, and the deformity was readily made out. The patient was admitted to St. Mark's Hospital August 28. No attempt was made to stretch the muscles by means of any extension appliance, as such a long time had elapsed since the accident. The entire extremity, from the hip-joint down, was surrounded by cloths saturated with a solution of carbonate of sodium, for the purpose of removing the accumulation of filth and dead epithelium with which the surface had become incrusted. These applications were renewed for two weeks, combined with daily washing and scrubbing, and on September 8 the limb was sufficiently clean to be put in bichloride dressing. Two days later this was removed, and an incision was made along the anterior aspect of the thigh down to the quadriceps muscle; the muscle-fibres were then separated by blunt dissection, the two fragments of the bone were exposed, and with the aid of a periosteal elevator the ends were cleared of a great mass of periosteum and thickened fibrous tissue. The

upper fragment was readily brought out through the incision, but before the lower fragment could be protruded it was necessary to remove a quarter of an inch of bone from each extremity. The thigh was then flexed upon itself posteriorly and the two fragments brought in contact, presenting an inverted letter V in appearance. The fragments were held firmly in place while strong extension was made by an assistant at the foot, and downward pressure over the apex of the triangle. This was done slowly, until the muscle-fibres gave way sufficiently to bring the ends into perfect apposition. The fragments were then again displaced upward and two holes drilled into each, one anteriorly and one externally. The heaviest grade of kangaroo tendon was then passed through the holes and tied after the fragments had again been put in perfect alignment. Owing to the traction produced by the firmly contracted muscles, position was maintained without any trouble, the main danger being anterior displacement of both fragments. The periosteum was sutured over the fragments and several stitches taken in the muscles: a counter-drain was brought out postero-externally, and after closing the incision through the skin a light coaptation splint was applied, and over this a plaster-of-Paris hip spica, with constant extension at the foot by an assistant until the plaster had thoroughly hardened. Forty-eight hours later the drain was removed without disturbing the dressings and a small pad of gauze was applied and held in place by a bandage. When the plaster was temporarily removed three weeks later, there was no marked evidence of union.

Five weeks after the operation the patient developed an acute fulminating appendicitis as the result of eating unripe fruit and herrings, which had been smuggled into the hospital by his friends during the nurse's absence. He was operated on ten hours after the onset of his symptoms. On account of this operation, the hip spica had to be removed, and it was left off for two weeks, during the repair of the appendicular wound. At the end of that time union of the femur had not yet taken place, and the plaster was again applied. At the end of the tenth week, union was manifesting itself, and four weeks later it was excellent. Since that time, slight passive motion has been employed upon the knee about once every fortnight, and the patient uses the joint as much as possible. Measurement of the thigh at the

present time shows about three-eighths of an inch shortening, while the knee can be flexed to fully a right angle.

AUTOPLASTY FOR UMBILICAL HERNIA.

Dr. Willy Meyer presented a woman, thirty-one years old, who had a large umbilical omental hernia which gave her a great deal of trouble. October 15, 1902, Dr. Meyer made a longitudinal incision from the xiphoid near to the symphysis pubis, and after excising the umbilicus, he dissected out the two recti muscles and brought them together in an overlapping position, the left one underneath the right. These were secured in this position with a dozen or more mattress sutures of chromicized catgut, and reinforced externally along the border of the right one with a continuous suture of the same material. A temporary cigarette rubber-tissue drain was introduced at either end of the wound. The wound healed by primary union; the patient made a perfect recovery, and up to the present time there are no evidences of any recurrence of the hernia.

Dr. Meyer said that the loosening of the two recti muscles in this case was a tedious and difficult operation, and in another similar case he would resort to the implantation of silver filigree.

VENTRAL HERNIA CLOSED BY THE SILVER FILIGREE METHOD.

Dr. Meyer presented a woman, fifty-three years old, who was operated on in 1901 in one of the city hospitals for a ventral hernia. In the course of the operation some trouble was encountered with the anæsthetic, and the wound was hastily closed with six silver-wire sutures. The patient was discharged with the wound healed. A month later five of the silver-wire sutures were removed at her home, on account of continuous pain.

When Dr. Meyer first saw the patient, last fall, she had a very small sinus, and in cutting down on this the remaining sixth silver-wire suture was found and removed. Several weeks later (November, 1902) he circumcised the granulating wound and closed the irregular hernial opening with a pad of silver filigree. The wound was then closed. The woman made an uneventful recovery. She has remained perfectly well, and there are no signs of a recurrence of the hernia.

Dr. Meyer presented a second patient, a woman, thirty-nine

years old, who was operated on by a colleague on December 11, 1900, for a pyosalpinx on the right side. Gauze drainage was inserted, and the operation was followed by the development of a very large ventral hernia. The protrusion was fully as large as a child's head.

For the relief of this hernia, Dr. Meyer operated on October 15, 1902. He circumcised the old sore down to the peritoneum, and exposed the border of the peritoneal aperture. The peritoneal cavity was not opened. Then, with the patient in the Trendelenburg position, the borders of the peritoneal aperture were brought together with heavy silver wire, and between these strands sutures of finer silver wire were interwoven. The operation was a rather tedious one, but the result was entirely successful. The integrity of the abdominal wall was perfectly restored, and thus far there were no signs of a recurrence. The woman attends to her daily work without any discomfort or pain.

Dr. Meyer presented a third patient, who had already been shown at a previous meeting of the Society, and a report of whose case was published in the ANNALS OF SURGERY for November, 1902. The patient was a woman, forty-three years old, upon whom, in 1894, vaginal hysterectomy was performed for myoma; five weeks later a bilateral oophorectomy was done; after another month, her left kidney was extirpated on account of a ureterovaginal fistula. Soon after she left her bed, a ventral hernia developed at the site of the median incision. To remedy this, a radical operation was done in 1898. The result was good, but a year later, while carrying coal up the cellar-stairs, the hernia recurred.

In the report of the case, published in the ANNALS OF SURGERY, Dr. Meyer had said that a slight omental protrusion had again become apparent, on account of which he proposed to reopen the scar. This he had done December 28 last, when he found the following condition: Instead of one corner of the filigree pad being torn loose, as had been expected, it was found that the net was torn through the centre, and that a fresh hernia protruded through this opening in the pad, while the borders of the pad itself were still firmly attached to the parietes. Many small pieces of fine silver wire were found loose in the fat. The hernial protrusion was replaced, and a new filigree pad inserted into the aperture of the original one, pulling the borders well together.

Dr. Meyer said that in dealing with cases of extensive umbilical or ventral herniæ in the future, he would resort to the use of the silver-filigree pad in those cases where the abdominal parietes were thick, but in those where the recti muscles had become separated to a considerable extent, and transverse fascia with peritoneum alone were covering the abdominal contents, he preferred making the wire netting himself during the operation. If the operation was done under strict aseptic precautions, he thought these pads would remain in place permanently, and that they would not, as had been suggested by a speaker at the last meeting of the Surgical Society, be expelled in the course of time as a foreign body. Mechanical means of this sort certainly had to be resorted to in order to close these large apertures in the abdominal wall, which formerly had been considered incurable troubles.

Dr. Howard Lilienthal said the patients shown by Dr. Meyer were apparently cured of what one would ofttimes consider an incurable condition. At the previous meeting of the Society, which Dr. Meyer had not been able to attend, two of the speakers referred to cases in which this operation had apparently proved unsatisfactory. According to their statements, in at least two of the cases operated on by Dr. Meyer the metal pad had apparently given rise to so much irritation that the wound had reopened after the primary closure.

In connection with these cases, Dr. Lilienthal emphasized the importance of an efficient abdominal support, either in the shape of a binder, or, what is almost as good or even better, the new style of corset—the so-called straight-front corset—which lifts the abdominal contents and holds then in that position. The usual high-waisted corset, or any form of corset which causes compression at the waist-line, should never be worn by a woman with a large, pendulous abdomen, particularly if there is any tendency to hernia.

Dr. Forbes Hawkes said that at the last meeting of the Society he had read a paper on this subject, and mentioned two cases which he had recently operated on by the method described by Dr. Meyer. Both of these patients were doing well at the present time, and there were no signs of a recurrence or the development of a sinus.

Dr. F. Kammerer said the case he had in mind when he

discussed the subject at the last meeting was one of Dr. Meyer's, in which the operation had been followed by abscess formation and necrosis of the fascia. Dr. Meyer would be better able to give the particulars of the case. The patient had been in the hospital about five months.

DR. MEYER said he had done this operation seven times upon six patients. One patient, the first on whom this operation was done, with a very large recurrent femoral hernia after an operation for acute strangulation, was first entirely cured. He worked soon after as hard as usual and had a partial recurrence. Then he developed intestinal obstruction, which had no reference to the silver-filigree insertion, and died after an operation (cf. ANNALS OF SURGERY, November, 1902). In the next four cases, three of whom had been presented to-night, the operation also was entirely successful. In one of these, to which Dr. Kiliani had referred at the previous meeting, the operation was done on December 20, 1902. The wound healed by primary union, but in the latter part of January the patient experienced an annoying sensation near the lower end of the scar, and an examination revealed that this was due to a small collection of blood within the tissues. This was opened, some blood and turbid serum escaped, and the wound healed entirely within ten days. In all other respects the case was entirely successful, and the patient was among those he had shown at this meeting as cured. Surely such a small collection of blood and serum cannot be called a phlegmon.

The sixth case was one of large, recurrent ventral hernia, with wide separation of the recti muscles. The dissection proved very long and tedious, and, after inserting a number of wire sutures, it was suggested, in order to save time, that the operation be completed by putting in a pad of silver filigree. This was done, and the abdominal parietes were closed. The case was apparently progressing favorably, with the exception of the pulse-rate, which remained high. This was attributed, for want of a better explanation, to a reflex cardiac neurosis; but on the eleventh day after the operation there was a sudden gush of intestinal contents through one of the small drains. The explanation of the symptoms in this case was now apparent. In inserting the continuous sutures around the pad, the needle was unfortunately once passed through the wall of a coil of intestine, re-

sulting, as shown above, in perforation, and the subsequent formation of a fæcal fistula. This could only be regarded as an accident in the course of the operation, and was no argument against the operation itself. This patient is still under treatment; it is expected that the wound will ultimately close, as the fæcal fistula as such has permanently closed.

POSTPNEUMONIC GANGRENE OF LEG.

Dr. Charles L. Gibson read a paper upon "Embolic Gangrene of the Leg as a Sequel of Acute Lobar Pneumonia."

ENLARGED PROSTATE.

Dr. Gibson presented a specimen removed from a man of sixty-five years who had suffered from symptoms attributable to enlarged prostate for ten years, and from almost complete retention for five. The residual urine amounted to fifteen ounces. An examination by the rectum showed the presence of a large, irregular prostate, the enlargement affecting chiefly the median lobe and predominating on the left side. He was operated on by Dr. Gibson in the summer of 1902. After making a small opening into the bladder above the pubes for the purpose of counterpressure, the enlarged prostate was shelled out through an incision made in the prostatic urethra. The operation was comparatively easy, and the man recovered very promptly, the immediate results being most gratifying. The wound closed rapidly, and the man had absolute control of his bladder, so that it never contained more than two or three ounces of residual urine. Subsequently, symptoms of vesical irritation developed, which resulted in troublesome dribbling, amounting almost to incontinence. An examination showed the presence of granulation tissue in the prostatic urethra. This region was being treated with instillations of silver nitrate in increasing strength, and under this method of treatment the urinary symptoms were decreasing in severity. The specimen weighs over six ounces.

Dr. Gibson presented a second specimen, which was removed from a man who was admitted to Bellevue Hospital December 22, 1902, suffering from urinary obstruction. His history, which was typical of prostatic hypertrophy, dated back some years. He had also had a stricture of the urethra, which was divided and

resulted in the formation of a perineal sinus, through which he discharged most of his urine. The presence of prostatic calculi was suspected on account of a grating sound which was elicited at times when a stiff instrument was introduced. An examination per rectum did not reveal any marked enlargement of the prostate.

The same operation was done in this case as in the previous one. After making an opening above for counterpressure, an external urethrotomy was done. Through this opening, no instrument could be passed into the bladder until three prostatic calculi had been removed. The prostate was then shelled out through the perineal wound *in toto*. Many small calculi were embedded in the substance of the organ. The man made a satisfactory recovery. He left the hospital in six weeks, with complete control of his bladder function.

DR. LILIENTHAL said the dribbling that occurred in the first case reported by Dr. Gibson was not infrequently observed after prostatectomy. Immediately following the operation, these patients usually have good control of the bladder function. Then for a period of weeks or months there may be incontinence, which in the course of time ceases and is again followed by full control. Dr. Lilienthal said he had the following theory to offer for this train of phenomena: Immediately after the operation, the scar at the neck of the bladder and in the urethra is succulent and forms a good valve; then the cicatrix becomes hardened, causing the formation of a rigid patent urethral tube permitting the urine to enter the deep urethra, and dribbling results. Later on the scar atrophies and again softens, and full control is once more regained.

HYDATID CYST OF THE LIVER.

DR. H. LILIENTHAL presented a specimen which was removed from a man who was operated on four weeks ago. For two or three years he had noticed a growing tumor in the right hypogastrium, in the region of the gall-bladder. It gave rise to little inconvenience, but finally became so large that he asked to have it removed. The diagnosis of echinococcus cyst was not made prior to the operation, although it was suspected as one of the possibilities. Its removal was attended with considerable difficulty, as it sprang from the lower portion of the liver and was adherent to the gall-bladder and to a large part of the colon and

stomach. The patient would have made a perfect and rapid recovery had it not been for persistent abdominal distention which was attributed to interference with the nervous supply of the colon. Upon the introduction of a rectal tube, gas would pass freely, but immediately upon the withdrawal of the tube it would reaccumulate. The distention was so marked that it finally caused the chromicized catgut sutures to give way, leaving the wound to heal by granulation.

Besides this large tumor, the patient had another smaller one springing from the lower part of the liver and adherent to the posterior parietes. The operation for the removal of the large anterior tumor proved so formidable that no attempt was made at the time to interfere with the second growth. Dr. Lilienthal said that he would make an effort to cure this tumor by incision and drainage.

Dr. Gibson said that years ago he had seen these cysts successfully treated by evacuating the contents through a minute puncture and then injecting an emulsion of iodoform and closing the wound. He had not seen this method employed recently. Salt solution and various other preparations were also employed for the same purpose.

Dr. Lilienthal said that this was his third case of hydatid cyst of the liver. In the first case, the growth involved the upper part of the liver, and was reached by cutting through the diaphragm and pushing the pleura out of the way. In the second case, the sac of the cyst had become calcareous after the removal of its contents by another surgeon.

REMOVAL OF THE SCAPULA FOR SARCOMA.

Dr. Lilienthal said that at the previous meeting of the Society he had presented a young girl with a sarcoma of the right scapula which had apparently greatly diminished in size under the use of the X-ray and injections of Coley's fluid, continued over several months. A few days after she had been shown at the meeting, signs of a recurrence of the growth became apparent, and the entire scapula was thereupon removed without further delay. The specimen showed that the upper part of the bone was absolutely free from disease, the sarcomatous involvement being confined to the lower part of the bone. Macroscopically, the soft parts surrounding the greater part of the scapula seemed to be

normal at the time of operating. There was apparently but little sarcomatous degeneration of the soft parts, but the bone itself was invaded and the periosteum pushed outward. Just above the scapula, in the posterior part of the supraclavicular region, there were a few glands about the size of French peas. They were removed and had been submitted to the pathologist, but the result of his examination was not yet known. The patient was apparently making a good recovery.

DR. F. KAMMERER said that Dr. Samuel Lloyd had recently reported several cases of carcinoma of the breast treated by the X-ray and subsequent operation in which extensive gangrene of the skin developed. Dr. Lloyd attributed the gangrene to the changes in the small arteries of the skin produced by the application of the rays and the additional trauma of the operation.

SUPPURATING HYDATID CYST OF THE LIVER.

DR. L. W. HOTCHKISS presented a specimen of hydatid cyst of the liver together with a number of microphotographs of the characteristic parasites.

The patient from whom this cyst was removed was an Italian, thirty-three years old, whose previous history could not be learned. He had been in this country about a year, and was well up to three months ago. He then began to suffer from indefinite symptoms, chiefly pain in the lower right chest, with loss of flesh and strength, and the early diagnosis was a probable empyema. This was afterwards excluded, and the conclusion was subsequently reached that the case was one of abscess of the liver, possibly hydatid in character. A slight thrill could be obtained just below the ribs.

An incision was made in the ninth intercostal space, and a considerable portion of the ninth rib removed. The diaphragm was then incised and an enormous hydatid cyst of the liver revealed. It contained fully a gallon of pus, together with hundreds of small and large cysts, which were evacuated through incision, and a portion of the cyst wall was excised for examination. Edge of cyst stitched to edges of incision. The patient was apparently on the road to recovery.

TRANSACTIONS

OF THE

CHICAGO SURGICAL SOCIETY.

Stated Meeting, April 6, 1903.

The President, JOHN B. MURPHY, M.D., in the Chair.

SURGICAL TREATMENT OF FRACTURES OF THE SPINE.

DR. JOHN E. OWENS read a paper with the above title, for which see September ANNALS OF SURGERY.

DR. E. WYLLYS ANDREWS said in his own surgical work he had made numerous operations to elevate the fragments or to perform laminectomy in cases of recent fractures, and after having met with discouragement he had drifted away from this practice. Personally he had never had a successful result, although he had seen and treated a good many cases. In at least two instances of recent fracture of the spine, he cut down and found about two inches of the spinal canal absolutely empty; there were not even the meninges present, but simply an empty bony canal. Two of his cases were bullet wounds through the spinal column, producing complete paraplegia, one being a recent case, the other an old one. He had not met with the slightest success in either case. The bullet had passed beyond the canal. In the recent case he removed a mass of depressed fragments, cleared out a quantity of blood-clots, and it seemed as though recovery might follow, but it did not.

He had seen a number of patients with fracture of the cervical vertebræ live from one day to a week or more, and in two of them, when reduction was made by pulling on the head, there was relief of symptoms almost instantly, and this relief could be maintained very much better by keeping up weight and pulley extension than by any other method; and while in several of these cases the temperature and pulse were good and vital functions were well maintained, not a single one of them was relieved permanently or lived more than a short time. The fact that a

small but regular percentage of cases of transverse myelitis and fracture recover without operation must not be overlooked. Some of the so-called cures by operation may have been cases which would have recovered without it.

Dr. M. L. Harris said that his experience in operating on fractures of the spine had been as discouraging as that of other surgeons. The one successful case of Hart and Stewart had renewed the interest of surgeons in this line of work, and perhaps offered a little hope. Surgeons were constantly operating with the forlorn hope of finding cases in which the symptoms were due to pressure from displaced fragments or from hæmorrhage; but they operated and operated, and did not find such cases. He had operated four times,—three times in the past year; three of them had fractures of the cervical vertebræ, and one a fracture of the lower dorsal. They all belonged to the class of immediate operations. One was operated within twenty-four hours; two within forty-eight hours, and one within four or five days. In all of them the cord was completely crushed. In the case involving the dorsal region, there were fully two and a half inches in which the cord was absolutely crushed. The three cervical cases died very soon; one of them lived a little longer than forty-eight hours. The case of dorsal fracture lived for some time; he did not know how long the patient did live. This patient had left the hospital for home and had lived some time after getting there.

During the past year he had seen three other cases, one involving the cervical region. This patient, a woman, died within a week. Autopsy showed complete crushing of the cord. In one the dorsal region was involved. He thought this was a favorable case to operate on, and urged the patient to submit to it; but he refused, and got well without operation. At any rate, the patient had improved very materially, so that he could get up and walk fairly well at the end of six months. The other case was a cervical fracture, and the patient died within thirty-six hours, without operation.

If surgeons could find cases in which the symptoms were due to blood-clot or simply to displacement of fragments, they might give relief by early operation; but the results of operations in other instances, with crushing of the cord, were unfavorable, unless continuity was restored, such as had been done in the

Hart and Stewart case. Dr. Harris imagined, however, that the cases in which this was possible would be very few, and that surgeons had to operate in many instances without finding favorable conditions to do so.

Dr. William E. Morgan said that he had about the same experience that most of the other gentlemen had had who had discussed the paper,—disappointment. But his experience had been limited to very few cases. He had been led to think that early trophic disturbances, as the early appearance of bed-sores, would be important indicators for early operation. Where bed-sores formed very early, or where the patient had sudden cold areas on points of the body which were under pressure, say within twenty-four or forty-eight hours, he believed then the condition of the patient was such as to stand anæsthesia and an operation, and he would consider such a case the one to operate on immediately. If he found no trophic disturbance within twenty-four or forty-eight hours, he would wait, provided the lesion was not very marked, either visible to the eye or upon palpation.

One case he had last year, and which made him feel as though he may not have done his duty to the patient, was one in which the trophic disturbances had appeared within forty-eight hours, but they were not very marked. The man's condition otherwise was fair, and he waited until the seventh or eighth day before he performed laminectomy. It was necessary to remove the fragments from three of the dorsal vertebræ; he found the cord contused but not lacerated at any point, and he entertained a good deal of hope regarding the case, because it seemed to him as though the patient ought to get well, judging from the amount of disturbance in the cord. There was little displacement of the vertebræ. The cord was lying quite free in the canal after he removed the fragments which were compressing it. The patient made very little improvement during a period of four weeks, and lived about eight months. Finally, he died of septic pneumonia. He thought it was safe to wait in cases where there was not very marked trophic disturbance, and even then one had to take chances. It was impossible to say how much of the cord was lacerated. He would not favor waiting in any case after trophic disturbance had occurred. As soon as slight necrosis of any point under pressure was noticed, he would advise trying at least laminectomy in the hope of saving once in a while a case.

Dr. John B. Murphy said he had come to some positive conclusions as to when to operate, and when not to operate, in cases of fracture of the spine. His reasons for arriving at these conclusions were: (1) In analyzing the factors, he found after operation had been performed on many cases, where there had been complete and immediate transverse paralysis, not a single case improved after operation. Second, where there was a partial paralysis of sensation and of motion remaining for a short distance below the transverse line, the cord had not been completely cut at that point, and in those cases alone was there some improvement following operative intervention.

He cited several cases that had come under his observation. The first case was observed in 1884. The patient fell from a trapeze, the accident being followed by an irregular paralysis from the sixth cervical down. It was irregular on one side, in that the patient's arm was not completely paralyzed on this side, while on the other it was paralyzed. Without operation, this man made a complete recovery in three months.

The second case was that of a man who was shot, and was brought to the County Hospital. The patient was shot in the neck, and stated positively that he did not fall at the time he was shot; but he fell after he was shot in the chest, there being two wounds. Dr. Murphy believed that the bullet wound in the chest occurred first, and that the patient fell immediately on being shot in the neck, and that the paralysis was due to the fact of the bullet having cut off the spinal cord. He would operate on a similar case to-day. This patient died on the fourth day after being shot. On making a post-mortem examination, there was no injury whatever of the spinal cord by the bullet, but it had passed through the bony canal, and there was hæmorrhage filling the canal from one end to the other. He thought the patient died as the result of compression from hæmorrhage. This was a case in which the indications were positive for operation on the strength of the patient's own statement, that he did not fall after he was shot in the neck, which he would have done if the bullet had cut off the cord at that time. Paralysis of motion and sensation was complete at the time he saw the patient. In this class of cases, as in the case detailed by Dr. Bevan, he thought relief might be obtained by puncture of the spinal cord and drainage of the blood through the lumbar vertebræ. In such a case as

Dr. Bevan had reported, where the spinal cord supposedly had been injured by the bullet, the diagnosis could have been verified by spinal puncture.

The next patient was a boy who had been injured in a football game, and was brought to the city from Duluth, Wisconsin. He had complete paralysis of motion and sensation. Operation was performed without the slightest benefit.

Another case, a man, was struck by a descending elevator, which produced paralysis of an irregular type rather than complete transverse paralysis. The speaker expressed the belief at the time that this patient did not need an operation; that he would recover without it, and he was recovering.

He next narrated the case of a man who fell from a scaffolding some twenty feet, sustaining a severe concussion, with some deformity of the spine, but no paralysis. Three weeks later paralysis set in, and in six weeks he was completely paralyzed, and remained so for eleven months before improvement began and continued, so that now paralysis has entirely disappeared. The question arose in his mind whether there was a fracture of the spine in this case. There was marked deformity, and this existed to this day, but the man was able to walk after the accident. Was there a crushing of the bodies of the vertebræ? If so, why did paralysis come on so late after the accident? It could not be charged to hæmorrhage; but he believed it was due to the reaction from the severe traumatism, and that as soon as the effect had passed off there was restoration of the cord. He was seeking more light on this particular class of cases, on the last one particularly. The conclusions he had reached were these: (1) That where there was primary complete transverse paralysis, operation did no good. (2) Where there was irregular paralysis, the great majority of cases he had seen eventually recovered without operation. (3) At the present time, if the paralysis was due to hæmorrhage, it could be relieved by spinal puncture if the patient was seen at once.

Dr. Owens, in closing the discussion, said that some cases he had observed were curious. He recalled a patient, whom he sees occasionally, who jumped from an engine and worked as a fireman for two weeks after sustaining an injury. At the end of that time he had ptosis and paralysis of motion and sensation in the lower extremities. He saw the case quite early a number

of times. There was no deviation whatever of the spinous processes of the vertebræ; but now the man had a perceptible deformity of the dorsal region. The injury occurred about a year ago. It was singular that a man, apparently injured as he was, could perform his laborious duties as fireman for two weeks after the injury, yet such was the case. The patient had not recovered from his paralysis, and had not improved under treatment.

He cited another case that he saw occasionally during the last six or seven months. There was no deviation of the spinous processes up to six weeks ago, when he began to notice a perceptible prominence in the dorsal region of two vertebræ. Some physicians, who saw the patient, said he had tuberculosis of the spine. He thought the case was similar to the one he had previously reported, the fireman, in whose case tuberculosis had taken place at the site of injury. The patient had no tenderness on pressure, and was able to get around with the aid of crutches. He had no pain. The speaker was rather disposed to exclude tuberculosis in this case.

He had seen a few skiagraphs which gave useful information in early cases.

As to whether a piece of bone might be pressing on the cord, or whether there was a deviation in some portion of the vertebræ, which might be relieved by operation, he did not know. If such was the case, operation might afford relief. He was interested in the recital of Dr. Murphy's cases. In those in which the paralysis came on late, in all probability, it was due to secondary degeneration of the cord.

REVIEWS OF BOOKS.

SPECIELLE MUSKELPHYSIOLOGIE ODER BEWEGUNGSLEHRE. By DR. R. DU BOIS-REYMOND, Privat-docent in Berlin. Mit 52 Abbildungen. Berlin: August Hirschwald, 1903.

The first systematic consideration accorded the functions of muscles dates back nearly a century, when Sir Charles Bell edited his "Anatomy and Philosophy of Expression." Somewhat more than sixty years later, 1867, Duchenne (de Boulogne), in his "Physiologie des Mouvements," was the first to apply the scientific methods of the laboratory, electricity, and chemical observations for the better understanding of muscle physiology. Since Duchenne's classical contribution there has been a very large output of articles bearing on muscle functions and analysis of joint motions, but no comprehensive work has been written since that date. A feature, therefore, of Reymond's monograph, appearing nearly fifty years after. Duchenne's consists in having coralled the fragments of literature. It differs as markedly from Duchenne's work as the latter differed from Bell's classic, for this "Muskelphysiologie oder Bewegungslehre" is alive with mechanics, dynamics, geometry, and mathematics applied to anatomy *in vivo et in cadavere*.

The subject-matter is considered under six headings. In the first part there are discussed the methods of investigating joint forms and joint motions by geometrical projections, frozen sections, casts, and models constructed on these; by instantaneous photography (Marey) and Röntgengrams. Still another chapter is devoted to general considerations of the muscles, the degree of their activity, the division of labor among the individual muscles. The second part covers the external and internal architecture of bones along the lines laid down by the mathematician

Cullman, and latterly built up by Meyer, Lesshoft, and Wolff. There follows in the third division, embracing the largest part of the book, a chapter on the general principles of joint mechanics applied to the classification of the varieties of joints, and a second chapter on the mechanism of each special joint in the body. In the succeeding fourth division the first chapter deals with the generalities of muscle dynamics, muscle forms, and the range of their activities. A chapter is devoted to the relation of innervation to muscle mechanics, comprising a study of associated, coördinated, concomitant, and synergistic actions. Chapter two covers the mechanics of special muscles and the movements of the trunk, the extremities, and the articulations by the muscles. The concluding fifth division takes in an analysis of the acts of standing and walking.

Reymond's book is dedicated to the genius of Otto Fischer, whose exhaustive researches in applied mechanics to joint actions and muscle functions made possible this work in a great measure. The modest share the author would reserve for himself is that of having built up a system on the heretofore scattered prolific contributions of Fischer, and by a compilation of all the newer literature to have supplemented the accepted teachings of Duchenne. Only one masterfully conversant as the author, himself a diligent writer in this abstract field, could have succeeded in reducing these abstruse calculations and speculations within the limits of the concrete so as to render them of possible service to the art of medicine and surgery. For the further development of tendon transplantations, and perhaps nerve grafting, it may be necessary to lean strongly upon these teachings.

Heretofore, mechanics in orthopædics was limited to appliances, but with arthro-kinematics (Fischer), osteo-dynamics (Cullman, Meyer, Wolff), and muscle mechanics of Duchenne, all masterly rendered by Reymond, a scientific foundation hitherto wanting has been found for orthopædy. It now remains for the teachers of orthopædy, neurology, and physiology to still

further popularize these teachings by indulging themselves in a studious perusal, which the complex problems discussed in this book calls for.

MARTIN W. WARE.

PRACTICAL OBSTETRICS. A Text-Book for Practitioners and Students. By EDWARD REYNOLDS, M.D., Assistant in Obstetrics, etc., and FRANKLIN S. NEWELL, M.D., Assistant in Obstetrics, Harvard University. 8vo, pp. 531. Philadelphia and New York: Lea Brothers & Co., 1902.

The first two divisions of this book follow closely the stereotyped plan of describing the anatomy of the female genitalia and their physiologic functions, and the hygiene and management of normal pregnancy and labor. The classification of presentations adopted by the authors may have some good reason as its justification, but O. D. A. and the like are very confusing to those who are in the habit of speaking of this position as "left occipito-anterior."

Especial stress is properly laid upon asepsis, for "the dirty finger-nail of the obstetrician still furnishes the gynæcologist with a large part of his material, and the chronic ill health of many women is due to the wilful neglect or carelessness of the physician who attended them in their confinement."

It is doubtful whether most American physicians prefer to examine their patients in the left lateral decubitus, and few would agree that this is the favorite position for delivery in the United States. Indeed, throughout the book many similar positive statements are made which may be true in Boston, but which certainly do not hold good in other parts of the country. The description of labor in the lateral position is so unusual in text-books that it is of value, though the illustrations borrowed from many different authorities fail to support the lateral hypothesis.

Obstetrical surgery, including manual dilatation, forceps, version, the destructive operations upon the child, and the major

operations upon the mother are especially well described, and the indications and contraindications of each operation clearly given. Deformed pelves, intrapelvic tumors, the hæmorrhages, placenta prævia, eclampsia, and the accidents of labor also summarize important chapters.

The division of the volume devoted to the puerperium is in many ways the best in the book, and the details of management of both mother and child will stand the test of trial.

As is usually the case where an author attempts to cover so wide a field in a single volume, many things are omitted which will seem important to the average reader. Thus Barnes's bags are mentioned, but the far more valuable contrivance of Champetier de Ribes is not mentioned; the details of the poor man's bath are excellently described, but the method of hypodermoclysis does not appear; forceps of little save an historic interest are depicted, but the solid blade forceps of Tucker-McLane is left out. Original illustrations are few if any, but the choice made from the works of other authors is an excellent one. All in all, the defects are few, and there are so many things to praise that the balance is large on the credit side of the account.

HENRY P. DE FOREST.

A TEXT-BOOK OF OBSTETRICS. By BARTON COOKE HIRST, M.D., Professor of Obstetrics in the University of Pennsylvania. Third Edition. 8vo, pp. 872. Philadelphia and London: W. B. Saunders & Co., 1903.

This volume is an excellent example of the type of text-book written by a single individual, and comprehensively covering the entire subject. Many indeed regard it as *facile princeps* among the works of this class; for advanced students and for the general practitioner it may well be regarded as the best volume upon obstetrics yet produced by a single author.

Pregnancy, Labor, the Puerperium, and the New-Born Infant are the principal divisional headings, but the author's method of

arrangement differs somewhat from that usually adopted. Anatomy and physiology are given ample recognition where these subjects must of necessity be considered, but pathology is really the key-note of the volume. Anomalies of development and pathologic changes both gross and microscopic are described with an attention to detail, with such wealth of illustrative material and clinical experience, and with the logical sequence of cause, symptoms, and treatment so well preserved throughout, that the discussion of each group of cases is of unusual interest.

Years of successful practice and a free use of the material thus accumulated are large factors in the success of the book. The numerous illustrations are, as a rule, singularly good, but the few colored plates are so crudely tinted that they compare unfavorably with the others made from drawings or from photographs. Unfortunately, too, although the index to the subject-matter is an ample one, there is no list of the illustrations, so they cannot readily be referred to in looking up the literature of a given topic.

HENRY P. DE FOREST.

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